CHAPTER 4 - AFFECTED ENVIRONMENT

This chapter describes the existing environmental characteristics of areas that may be affected by construction and operation of the Denny/Lake Union Project. The project area encompasses South Lake Union and Elliott Bay subbasins, which incorporate areas east, west and south of Lake Union, a portion of Capitol Hill, east of Elliott Bay between Galer Street and Denny Way, south of Queen Anne Hill (at West McGraw Street), and north of Virginia Street within the City of Seattle.

The first six sections describe the natural environment: Earth Resources, Air Resources, Water Resources, Biological Resources, and Energy. The last seven sections describe the built, or human, environment: Environmental Health, Noise, Land and Shoreline Use, Recreation, Aesthetics, Historical and Cultural Preservation, Transportation, and Public Utilities and Services.

There are no wetlands, floodplains, important farmlands, wild and scenic rivers, national natural landmarks, or barrier islands within or adjacent to the project area.

4.1 EARTH RESOURCES

The project area's topography, soils, and surface geology are the result of the most recent Puget Sound region glaciation (Vashon), which occurred about 15,000 years ago; these conditions are described below.

4.1.1 Topography

Seattle, located on the eastern shore of Puget Sound, occupies a basin between the Cascade Range to the east and the Olympic Mountains (coast range) to the west. Puget Sound was scoured by multiple glaciations that resulted in the north-south trend of the surviving ridges, valleys, deep troughs occupied by lakes and streams, and deep inlets of Puget Sound (NBBJ 1994; Galster & Laprade 1991).

South Lake Union Subbasin. Elevations in the South Lake Union Subbasin range from 150 feet mean sea level (m.s.l.) at the highest point to mean sea level near Lake Union (Figure 4-1).

Elliott Bay Subbasin. Elevations in the Elliott Bay Subbasin range from approximately 400 feet m.s.l. on Queen Anne Hill to approximately 15 feet m.s.l. along Elliott Bay (see Figure 4-1). Elevations in Elliott Bay in the project area are shown on Figure 4-2.

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4.1.2 Geology

Four distinct geologic units can be found within the study areas. These units, from youngest to oldest include: Vashon till (which ranges from gravely, sandy silt to silty sand with varied quantities of clay, cobbles, and boulders), Esperance Sand/Advance Outwash deposits (sand, coarse materials), Lawton Clay (laminated clays and silt), and Pre-Vashon Quaternary glacial and nonglacial sediments (which include very fine sands and silts overlying fine to medium sands with sand and gravel lenses) (Galster & Laprade 1991).

Figure 4-1

Figure 4-2

4.1.3 Geologic Hazards

The primary geologic hazards considered for the South Lake Union and Elliott Bay Subbasins include: erosion, seismic hazards, landslide and slope instability, flood prone areas, and volcanic hazards; however, flood prone areas and volcanic hazards are minimal.

4.1.3.1 Erosion

Major contributors to accelerated erosion include removal of vegetation, modification of topography, and uncontrolled surface water runoff. Some soil types are more prone to erosion: soils with high silt and/or clay content; soils found on moderate to steep slopes; and soils overlaying impermeable rock or soil layers. King County has defined erosion hazard areas as those areas having slope inclinations greater than 15 percent (King County 1995).

South Lake Union Subbasin. The majority of the project area has relatively gentle grades, however, slopes of 15 percent and greater exist along the western shore of Lake Union. Erosion hazards are present in this area due to the steep slopes and soft sediments.

Elliott Bay Subbasin. Slopes of 15 percent and greater are found in the area surrounding Queen Anne Hill and in the area of Kinnear Park near Elliott Bay. Soils in the Elliott Bay Subbasin are generally associated with erosion hazards. High sensitivity soils consist of uniform fine sands or silts highly susceptible to erosion.. The least sensitive soils consist of well graded soils with some gravel, such as glacial till or coarse grained outwash, and cohesive soils. Moderately susceptible soils include fine grained outwash with minor gravel (Brown and Caldwell and Metro 1989).

4.1.3.2 Seismic

Seismic hazards can occur as surface fault ruptures, ground shaking, liquefaction, and in some cases, landslides (McCrumb et. al. 1989). The Puget Sound region is seismically active and has experienced thousands of earthquakes; the U.S. Geological Survey has designated the Puget Sound area as a Zone 3 (Class III) seismic/landslide risk area. Zone 3 is described as a zone of major seismic risk potential in conjunction with earthquakes having intensities of 4.0 or higher on the standard Richter scale. A seismic hazard map that divides the Seattle metropolitan area into three sensitivity zones on the basis of underlying geology was recently produced for the Seattle Water Department. The sensitivity zones are: a) bedrock areas, b) areas of glacially-consolidated sediments, and c) areas of Holocene alluvium, fill, potentially unstable slopes, colluvium, peat, and other areas characterized by unconsolidated deposits (Galster & Laprade 1991). Areas of bedrock and glacially-consolidated sediments are typically less sensitive than the other areas listed. The landslide section below discusses seismically-induced landslides.

South Lake Union Subbasin. Areas along the western perimeter of Lake Union and north of Mercer Street along the southern perimeter of Lake Union have a high liquefaction potential (Seattle 1992). Liquefaction is the loss of strength due to earthquake-induced ground motions and can trigger surface settlement and lateral spreading (NBBJ 1994). These areas have any combination of the following attributes that contribute to the areas sensitivity: steep slopes,

glacially-consolidated sediments, fill and/or unconsolidated deposits. Figure 4-1 illustrates the location of these areas.

Elliott Bay Subbasin. The shoreline area approximately southwest of Elliott Avenue along the shore of Elliott Bay has a high liquefaction potential (Seattle 1992). Figure 4-1 illustrates areas with a high liquefaction potential.

4.1.3.3 Landslide and Slope Instability

Landslide hazards pertain to the potential for downslope movement of earth materials under the influence of gravity. The physical parameters which affect the potential for landslides include the type of soil or rock, slope geometry, groundwater, vegetation, ground vibration (i.e., earthquakes or blasting), and modifications of the above parameters induced by human activities (Thorsen 1989). King County created a classification system for landslide hazards, defined as: areas with slopes in excess of 40 percent regardless of underlying soil or bedrock conditions, areas sloping greater than 15 percent and underlain by impermeable soils, areas in which landslides have previously occurred, areas where fill is low quality or strength, and slope areas flatter than 15 percent where adverse surface or groundwater conditions are present (King County 1995).

South Lake Union Subbasin. An area with slopes greater than 40 percent is located parallel to the western shoreline of Lake Union along Aurora Avenue (Seattle 1992). Areas with previous or potential landslides are shown on Figure 4-1.

Elliott Bay Subbasin. Areas with slopes greater than 40 percent are shown on Figure 4-1. These areas are located on the slopes of Queen Anne Hill. The area between Olympic Way/West Olympic Place and Elliott Avenue is also a potential slide area (Seattle 1992). Areas with known historic landslides occur in localized "pockets" in the vicinity of Olympic Way/West Olympic Place and Elliott Avenue (Seattle 1992).

4.1.3.4 Flood Hazards

No floodplains or flood prone areas within the study area are identified in the Seattle Environmental Critical Areas Ordinance (Seattle 1992).

4.1.3.5 Volcanic Hazards

The nearest potential volcanic hazard is Mount Rainier, located 60 miles southeast of Seattle. The nature and extent of the hazard would depend upon the type of volcanic activity, wind direction, and other factors, but generally is not considered a significant risk to the study area.

4.1.4 Soils and Sediments

Soils and sediments are different. Soils are the unconsolidated mineral and organic material on the surface of the earth which has been subjected to and influenced by environmental factors. Sediments are mineral and organic solid materials (e.g., soils) that are in suspension, being transported, or have been

moved from the place of origin by air, water, gravity or ice and is now resting on the surface of the earth above or below sea level (Soil Conservation Society of America 1982).

4.1.4.1 Soils

The *Soil Survey of King County Area, Washington* (SCS 1973) was reviewed for information pertaining to soils in the South Lake Union and Elliott Bay Subbasins; however, it did not contain information on the study area. Personal communication with the Soil Conservation Service - Renton Field Office (Heacock 1995) indicated that this area was urbanized; maps indicate the area is urban land with variable soils. The soils in the vicinity of the study area were largely derived from the Vashon glaciation and post-glacial deposition (NBBJ 1994).

South Lake Union Subbasin. Because of the pattern of glaciation in the area, glacial deposits are located near the surface at higher elevations in the eastern and western portions of the South Lake Union Subbasin and are encountered deeper at lower elevations. Lower elevations adjacent to the lake reflect more recent deposits such as alluvial deposits, colluvium, and artificial filling (NBBJ 1994).

The width (east to west) and depth of the post-glacial deposits appear to increase in a northerly direction in lower elevations of the South Lake Union Subbasin. This is influenced by the narrow valley floor caused by Denny Hill and filling activities near the Lake Union shoreline. The post-glacial deposits consist of clay, silt, and very loose to medium dense, silty to clean sand (NBBJ 1994).

Fill soils contain building debris (e.g., concrete, glass, and brick), wood debris, and sawdust from a lumber company which occupied the area south of Lake Union in the 1900s (NBBJ 1994). The area to the south of Lake Union, occupied by the existing Naval Reserve Center, was constructed on a man-made peninsula consisting of about 60 feet of fill overlying organic clay, peat, and dense sand (ranging in depth from 10 to 30 feet). The fill consists predominantly of miscellaneous debris and wood chips (NBBJ 1994).

Elliott Bay Subbasin. Soil profiles from Elliott Bay through the Seattle Center indicate areas of fill, soils derived from Vashon till, glacial outwash, and glaciolacustrine beds (Brown and Caldwell and Metro 1989). Finer materials, including silts and sands are thought to have been deposited during periods when the area was under deep water. The coarser material (e.g., bedded sands, gravely sands, and sandy gravels) are determined to have been deposited in outwash streams and shallow waters from a relatively high energy environment closer to the glacier front (Brown and Caldwell and Metro 1989).

4.1.4.2 Sediments

Potentially contaminated areas are located primarily in the more industrialized sections of Seattle (i.e., Elliott Bay waterfront and Lake Union). Contaminated soils and/or sediments may be present along some of the alternative conveyance routes. Preliminary identification of possible contaminated areas is useful in evaluating the potential for encountering contaminated soil and/or sediments during construction.

In recent years, significantly contaminated soils and sediments originating from excavation and construction in industrial and commercial areas have been considered a waste stream by regulatory agencies. State and federal agencies have taken the position that excavated soils may be classified as "hazardous wastes" if they contain sufficient chemical contamination to be classified as a "dangerous waste mixture" under the "Washington State Dangerous Waste Regulations" (WAC 173-303) (Ecology 1995).

Testing and disposal of large quantities of contaminated soils, sediments, and dredged materials can be complicated, time-consuming, and expensive. Because of limited disposal options, the inadvertent discovery of contaminated soils during pipeline construction can present a constraint to construction.

Individual contaminated sites are identified in EPA data bases (Comprehensive Environmental Response, Compensation, and Liability Act Information System [CERCLIS] list, Resource Conservation Recovery Act [RCRA] Notifiers List), as well as other regulatory agency files (e.g., Washington State Department of Ecology). Several small businesses and one federal facility in the study area have been investigated in the past to verify proper hazardous waste management practices; all investigations are now closed and have been designated as NFA, or No Further Action. The potential exists to encounter soil contamination around small industrial facilities, dry cleaners, gas stations, auto repair shops, and similar businesses during construction of pipelines or tunnels. Encountering contaminated soils or groundwater would have an impact on construction cost and schedule.

4.1.4.3 Contaminated Onshore Soils and Sediments

Onshore soils and sediments can become contaminated from various sources including deposition of contaminated materials, contaminated runoff, and leaks and spills from pipelines and underground storage tanks. Direct contact with these soils, sediments or contaminated groundwater may pose a risk to humans, plants or animals. Contamination can also occur from historic land uses and natural processes. Historically, sawmills cut wood on the edge of various waterbodies around Seattle, including Lake Union and Elliott Bay. Sawdust and wood chips were used to fill in low and swampy areas and were eventually covered with soil. However, sawdust and wood chips, as well as old lake or wetland sediments, contain organic materials which degrade over time producing methane vapors.

South Lake Union Subbasin. In 1980, a gasoline leak was discovered at the UNOCAL gas station at Westlake and Mercer avenues (see Figure 2-7 for a location of the contaminated sediments and groundwater). Remediation has collected three-quarters of the leaked gasoline. The remaining one-quarter is locked into the sawdust and wood chips mixed in soils. Monitoring in the area continues and no petroleum vapors are currently detected, however, explosive levels (20 to 30 percent) of methane has been detected. There are also approximately 50 documented leaking underground storage tanks near the project area. The Maryall site, located on Roy Street between Eighth Avenue North and Dexter Avenue, has known total petroleum hydrocarbons (TPH), solvents and BETX present (Black and Veatch 1997a). Solvents were discovered in the groundwater sample taken from a boring hole on Roy Street near a dry cleaner known to have released chemicals off site. A coal gasification plant was located between Eighth and Ninth Avenue North immediately north of Republican Street; however, there is no known contamination present.

Elliott Bay Subbasin. Table 4-1 summarizes the major potential contaminant sources that were identified during predesign in the Elliott Bay Subbasin. Previous environmental studies have been conducted on the Elliott West site. Five underground storage tanks have been removed from the property along with approximately 100 cubic yards of petroleum contaminated soil. An estimated 10 cubic yards of soil with concentrations of TPH in excess of the Washington State Department of Ecology *Model Toxics Control Act* (MTCA) Method A cleanup level remain on site at a former UST location near the railroad tracks (Boateng & Associates, Inc. 1995). Another detection of TPH above MTCA cleanup rate has also been reported in the vicinity of the former Blackstock Lumber building. The volume of the contaminated soil, if any, in that area is unknown. Groundwater contamination in excess of the MTCA Method A cleanup level for TPH was reported in one monitoring well on site. Based on the information collected during the Boateng & Associates, Inc. (1995) study, the potential for additional significant environmental contamination is low to moderate. Darigold, Inc., located adjacent to the Elliott West site to the north, is listed on Ecology's Leaking Underground Storage Tank list dated April 14, 1994. However, this spill was limited to the soil and does not appear to pose any significant threat to the environmental integrity of the soil and/or groundwater beneath the Elliott West site (Boateng & Associates, Inc. 1995). UNOCAL Land and Development Company owns property near Pier 71 on the Elliott Bay waterfront (1.5 acres of tidelands and 6 acres of upland between Broad and Bay streets). In the early 1970's, petroleum was released on the upland portion; UNOCAL has been working with Ecology in cleaning the site since 1988 (Kellar 1997). This petroleum release is not near proposed project facilities.

4.1.4.4 Contaminated Offshore Sediments

Many contaminants in combined sewer overflows, secondary treated wastewater, and stormwater discharges are bound to particulates. A large portion of the contaminant load from the above sources can settle to the offshore sediments, which act as a sink for particulate-bound contaminants. Direct contact with these contaminated sediments and interstitial water may pose a risk of long-term, chronic exposure for benthic and epibenthic fish, and invertebrate organisms (King County Metro 1995b).

Testing and disposal of contaminated sediments from Elliott Bay is controlled under the U.S. Army Corps of Engineers (COE) Section 10/404 permitting program with input from numerous other federal, state, and local resource agencies. The COE requires that testing and disposal comply with guidelines established under Phase I of the Puget Sound Dredged Disposal Analysis (PSDDA) Management Plan Report and as updated via the Phase II Management Plan Report and the PSDDA annual review process (Fox 1995). PSDDA described a rigorous program for the testing of sediments proposed to be dredged, set new criteria for the open-water disposal of dredged materials, and established a new open-water disposal site north of the West Duwamish Waterway in Elliott Bay (COE 1988; COE 1989).

In 1991, Ecology published sediment management standards (Chapter 173-204 WAC) (Ecology 1991). The purpose of the standards is to "reduce and ultimately eliminate adverse effects on biological resources and significant health threats to humans from surface sediment contamination..." The sediment quality standards provide a regulatory and management goal for the quality of sediments

Table 4-1
Major Potential Contaminant Sources
Elliott Bay Subbasin

Site Name	Address	Contaminants*	Affected Media
Texaco	630 Elliott Ave. W.	TPH, Lead	Soil, Groundwater
Darigold	635 Elliott Ave. W.	TPH	Soil, Groundwater
Elliott West site (formerly Blackstock Lumber)	535 Elliott Ave. W.	TPH	Soil, Groundwater
Elliott Bay Office Park (formerly gas station)	300 Elliott Ave. W.	TPH	Soil, Groundwater
EPA "Block 160" Site (previously a creosote pole facility and fuel oil facility)	333 Elliott Ave. W.	Metals, TPH, PAHs	Soil, Groundwater

* Acronyms: TPH - total petroleum hydrocarbons, PAH - polycyclic aromatic hydrocarbons
Source: Black & Veatch 1997a.

throughout the state. At this time Ecology has formally promulgated sediment quality standards for marine sediments only, which covers Elliott Bay. Draft freshwater sediment standards are currently being developed by Ecology which would cover Lake Union. However, because of the Ballard Locks, Lake Union does receive an infusion of salt water throughout the year.

King County is currently evaluating sediment quality relative to human health and ecological risks in Elliott Bay and Lake Union (King County Metro 1995b). This *Draft Water Quality Assessment* included identification of contaminants of concern, exposure pathways, and evaluation of alternatives being considered as part of the RWSP. A model was developed to calculate relative risk indices for aquatic organisms and sediment quality. Quotients for sediment quality were derived using the Sediment Management Standards for Puget Sound (Ecology 1991). These standards were applied to Lake Union, as well as Elliott Bay, because of the lack of freshwater sediment criteria. Results from this evaluation are discussed below.

South Lake Union Subbasin. Sediments in Lake Union have been extensively analyzed, particularly in the area near Gas Works Park and the southern end of the lake. Elevated levels of inorganic substances (metals) and organic compounds have been found in Lake Union. The *Draft Water Quality Assessment* identified several metals of concern in Lake Union sediments including arsenic, cadmium, chromium, copper, lead, mercury, nickel, silver, and zinc. Organic compounds of concern in Lake Union sediments include benzoic acid, butylbenzyl phthalate, bis (2-ethylhexyl)

phthalate, and total polycyclic aromatic hydrocarbons (PAH). Sediments in areas adjacent to CSO and stormwater outfalls have elevated concentrations of both metals and organic compounds.

Elliott Bay Subbasin. Potential sources of contaminants to Elliott Bay include stormwater, CSOs, port activities, atmospheric deposition, industrial discharges, and the Duwamish River discharge. The Denny Way CSO has had one of the highest volumes of overflow in the King County system, thus contributing contaminants to sediments in the nearshore area (King County Metro 1995a,b).

In an effort to isolate contaminated bottom sediments from marine organisms, Metro and Seattle implemented two sediment capping projects in Elliott Bay. Metro sponsored the Denny Way capping project in 1990, which was completed by the COE using clean sand from routine maintenance projects. The Denny Way Sediment Cap is three feet thick and covers three acres; however, another 10-15 acres both closer to shore and farther offshore than the capped area need to be capped or remediated. The cap has been sampled from 1990 through 1994 (Romberg 1995). Sampling results indicated that contaminants were not migrating up into the cap from below. Part of the surface of the cap is gradually becoming recontaminated from the Denny Way CSO (Wilson and Romberg 1996). Seattle's Pier 53-55 capping project, conducted in 1992, covers 4.5 acres. Capping depth on 1.5 acres was reduced to one to two feet thick to minimize loss of navigation depth and designated as an Enhanced Recovery Area. Two years of sampling at this site indicated an unanticipated increase in PAH concentrations that was attributed to piling removal activities at an adjacent pier. The area outside the Denny Way Sediment Cap is on Ecology's new MTCA list as Site #EB 26 indicating remediation is required.

Contaminants continue to be present in sediments along Elliott Bay's central waterfront at concentrations of concern; recent evaluations indicate elevated levels of metals and organic compounds (King County Metro 1995b). Metals of concern in Elliott Bay sediments are similar to those in Lake Union and include arsenic, cadmium, chromium, copper, lead, mercury, nickel, silver, and zinc. Organic compounds of concern include: benzoic acid and butylbenzyl phthalate. Sediment concentrations are highest in areas with corresponding CSO outfalls (King County Metro 1995b).

In March 1996, the Elliott Bay/Duwamish Restoration Program completed dives off of Myrtle Edwards Park to determine substrate characteristics and biological species for habitat restoration (Buckley and Bookheim 1996). Physical profile data recorded included compaction, slope, substrate, and depth. Transects occurred along lines extending offshore from the base of the riprap. In general, a marginally firm surface layer covered a soft substrate. The surface layers of the substrate below approximately -6 mean-lower-low-water (MLLW) were "extremely flocculent and easily suspended in the water column with the least disturbance from diving activities on the bottom. This created zero visibility...as well as contact between bare skin and the sediment material, and the possibility for ingesting the sediment material" (Buckley and Bookheim 1996). Due to the location of the evaluated area to the Denny Way CSO, the sediment material is highly suspect for toxic substances and high amounts of fecal coliform. The bottom contours indicated a relatively uniformly sloping substrate within the survey area.

4.2 AIR RESOURCES

Appendix E contains additional information and tables referenced in this section.

4.2.1 Prevailing Winds and Weather Patterns

The Puget Sound area has a typical marine climate with prevailing moisture laden winds originating from the Pacific Ocean. This phenomenon, combined with the mountainous terrain, creates relatively high overall annual precipitation. The effect of Puget Sound and the barrier provided by the Cascade Mountains Range to the east creates mild winters and cool summers.

Two major meteorological patterns dominate local weather. In late spring, an eastern Pacific high pressure ridge is located off the Washington-Oregon coasts. This ridge forces Pacific storms north of Washington, resulting in dry, stable conditions in the Puget Sound area. High temperatures occur in late July and early August; winds are relatively light and frequently blow from the north and northwest in summer.

During winter months, a relatively stationary low pressure region often develops in the Aleutian Islands of Alaska, which regularly sends Pacific storms through British Columbia and Puget Sound. This system creates the typical rainy winters of the Pacific Northwest; winds are generally from the south but locally influenced by terrain.

Temperature inversions, formed by low solar heating of the land, are common in the winter. Inversions may last several days precluding pollutants from being dispersed by the wind. Several times during the months of January, February, October, November, or December, poor dispersion persists for more than 24 hours and may result in the declaration of an "air pollution episode" or local "impaired air quality".

4.2.2 Regulatory Overview

The three agencies that have air quality jurisdiction for construction and/or operation in the project area are EPA, Ecology, and the Puget Sound Air Pollution Control Agency (PSAPCA). Although their regulations are similar, each agency has developed its own standards (Appendix E). Unless the state or local agency has adopted a more stringent standard, the EPA standards apply. Of the three agencies with jurisdiction, PSAPCA has permitting responsibility for construction sites in Seattle, possibly requiring a Notice of Construction (NOC) air quality permit for facilities which include air pollution control components. The objective of the NOC permit is to define the air pollution controls used at a construction site. If facilities such as a storage tank or pump station include odor control facilities, a permit will be required. Construction of pipelines will not require a permit (Williams 1995). If a permit is necessary, PSAPCA will require the applicant to apply the Best Available Control Technology (BACT) for reducing air emissions from the project.

PSAPCA also monitors odor generation and transmission. The basic criterion used by PSAPCA to determine the adequacy of proposed controls for an odor source is the prevention of odors leaving the site. Once in progress, PSAPCA will inspect a project site regularly or upon the receipt of complaints. If odors are detected leaving the site, PSAPCA will issue a Notice of Violation which may result in a fine and possible implementation of a corrective action plan until resolution of the air quality problem.

4.2.3 Ambient Air Quality

PSAPCA uses the national Pollutant Standards Index (PSI) to report daily and summarize annual air quality. The index accounts for varying levels of pollutants, including carbon monoxide, ozone, sulfur dioxide, and particulate matter. The pollutant with the highest index value on any given day determines the PSI for that day. The index value describes the air quality as "Good", "Moderate", "Unhealthful", or "Very Unhealthful". Any pollutant measurement exceeding the short-term national primary standard causes the index value to be in the Unhealthful category. In 1993, Seattle had 251 Good PSI days and 114 Moderate PSI days. The highest PSI of 88 for particulate matter (100 is the limit between Moderate and Unhealthful) occurred on January 11, 1993 (PSAPCA 1993).

The National Ambient Air Quality Standards (NAAQS) specify that one-hour carbon monoxide (CO) concentrations may not exceed 35 parts per million (ppm) and eight-hour average concentrations may not exceed 9 ppm more than once annually (see Appendix E, Table E-1). NAAQS for ozone specify that one-hour average concentrations may not exceed 0.12 ppm more than once annually.

South Lake Union Subbasin. The South Lake Union Subbasin lies within the NAAQS marginal ozone non-attainment area and the moderate CO non-attainment area. Moderate CO and marginal ozone non-attainment status requires the least stringent control actions of the non-attainment classifications under the Clean Air Act Amendments of 1990.

PSAPCA maintains an air quality station near south Lake Union at Fourth Avenue and Pike Street. In 1993, there were no NAAQS CO exceedances monitored. The highest recorded CO eight-hour average concentration between 1991 and 1993 was 6.9 ppm. Additional CO measurements in south Lake Union are listed in Appendix E, Table E-2.

The primary sources of air pollutants in the South Lake Union Subbasin are automobile emissions from roadway traffic and commercial and light industrial activity. Streets with major traffic volumes in the area include Denny Way and Mercer Street, which are east-west corridors. CO concentrations consistently exceed the 8-hour NAAQS CO concentration in the South Lake Union area and the intersection of Mercer and Westlake exceeds the 1-hour NAAQS for CO.

Elliott Bay Subbasin. Downtown Seattle is a non-attainment area for carbon monoxide. The primary air quality issue is pollution emitted from traffic. Heavy traffic streets in the area include: Elliott Avenue, Denny Way, and Mercer Street. Elliott Avenue receives high truck traffic and both Denny Way and Mercer Street are major east-west corridors.

4.2.4 Odors

Sources of odor in the study area include vehicular emissions, industrial discharges, and emissions from wastewater facilities. Vehicular exhaust fumes, largely CO and sulfur compounds, are most noticeable along heavily-used roadways during peak traffic hours (e.g., along Mercer Street at 5:00 pm). Odor receptors include other vehicular occupants, pedestrians, and occupants of surrounding buildings.

The majority of odorous compounds found in municipal wastewater systems are reduced sulfur and nitrogen-based compounds including hydrogen sulfide, methyl mercaptan, and ammonia. Odor causing

compounds are formed by the anaerobic decomposition of sulfur and nitrogen-containing material in wastewater. The anaerobic bacteria responsible for the decomposition of these compounds reside in a slime layer which forms on the wetted surface of pipes and in sludge deposits. Odor potential is increased in areas where the wastewater is in contact with the slime layer for extended periods of time.

Odors will be present where gases from the wastewater-bacteria interaction are emitted. Potential odor generation areas include pipelines, manholes, pump stations, regulator stations, force main discharges, inverted siphons, storage facilities, treatment facilities, and outfalls. Wet weather results in significant inflows of stormwater to the combined sewer system. This stormwater dilutes the concentration of sulfur and nitrogen compounds in wastewater, lowers the temperature, and increases the velocity through the conveyance system. These factors reduce the potential for significant odor generation; however, long conveyance distances or increased storage times may cause stagnation, oxygen deprivation, and accompanying odors in wastewater facilities. Odor receptors include occupants of nearby buildings, passing motorists, and pedestrians.

South Lake Union Subbasin. Odor sources in the South Lake Union Subbasin are predominantly from vehicular traffic (refer to Section 4.12.1 Transportation for a discussion of traffic volumes in the area). Potential odor from wastewater facilities is diffuse; the network of pipes, pump stations, and regulators in South Lake Union may occasionally generate noticeable odors, however, no odor complaints have been filed with the County (Greenwald 1995). Odor receptors in this subbasin include businesses, residences, and boaters in the south end of the lake (refer to Section 4.8 Land and Shoreline Use).

Elliott Bay Subbasin. In the Elliott Bay Subbasin, the Denny Regulator is a potential source of odor particularly during warm periods. Large amounts of industrial waste and long residence time in the pipes between the upstream station and the regulator are thought to be the causes of odor at this site. County staff periodically receive comments or complaints about odors, however, none have been received for the Denny Regulator (Greenwald 1995). Other potential wastewater-related odor sources in the subbasin include the Interbay Pump Station and Force Main Discharge, which have periodically been the subject of complaints. Additional odor sources in the Elliott Bay Subbasin include vehicular exhaust, particularly from truck and automobile traffic along Elliott Avenue and rail-related emissions. Occasionally odors caused by decomposing plants and animals, escaping gases from the sediments, and other sources are noticed along the beach in Myrtle Edwards and Elliott Bay Parks. Odor receptors in this area include users of the parks, businesses along Elliott Avenue, and residents of condominiums along Mercer Street and lower Queen Anne Hill.

4.3 WATER RESOURCES

4.3.1 History

Lake Union and Elliott Bay have been centers for industrial and commercial activities in Seattle for more than 100 years. Since the late 1880's, major industrial, commercial and residential developments have expanded in the immediate watershed and surrounding areas. This increased development led to considerable discharges of raw sewage and stormwater, causing release of nutrients, metals and organic chemicals into surface waters

Immediately surrounding Lake Union and Elliott Bay is approximately 26 square miles (67 square kilometers) of highly developed land that comprises metropolitan Seattle. Both waterbodies have historically been and continue to be highly affected by this adjacent highly urbanized land use. Currently, the primary sources of pollutant loadings to Lake Union and Elliott Bay are from discharges of industrial wastewater, marina and boat waste, CSOs, and stormwater.

4.3.2 Surface Water Hydrology

Additional detail of the hydrology of Lake Union and Elliott Bay is provided in the *Draft Water Quality Assessment* (King County Metro 1995b) incorporated by reference to this document.

South Lake Union Subbasin. Lake Union is approximately 581 acres (235 hectares) in area, with a mean depth of 32 feet (10 meters). The deepest section in the lake, a canyon 50 to 65 feet (15 to 20 meters) deep, is located parallel to and near the western shore. Water elevation is also controlled at the Chittenden Locks and is two feet higher during the summer months.

Water circulation in Lake Union is complex. In general, water flushes out from Lake Union relatively quickly during the winter months with high water inputs from Lake Washington. During certain periods of the year Lake Union is stratified by two separate processes:
1) intrusion of a saline wedge starting at the locks, and 2) thermal heating of the upper water layer by solar radiation (King County Metro 1995b). The degree of stratification is primarily dependent on water temperature and secondarily on the degree of saltwater intrusion from the locks (Tomlinson et al. 1977).

Lake Union is most stratified during the summer, when influences from the locks are greatest and inputs from stormwater are lowest. Saltwater intrusion and stratification generally occur in July when water inflow from Lake Washington decreases. In the winter, there is no stratification and little saltwater intrusion.

Elliott Bay Subbasin. For this discussion, Elliott Bay is defined as the waterbody east of a line between Fourmile Rock and Alki Point (Figure 4-3). Inner Elliott Bay is defined as that area inside a line between Duwamish Head and Smith Cove; outer Elliott Bay lies outside this line (King County Metro 1995b). Elliott Bay is approximately 8 square miles (21 square kilometers) and located on the eastern shore in central Puget Sound. The inner bay receives fresh water from the Duwamish River and most of the stormwater runoff from the highly developed drainage basin of metropolitan Seattle. The bottom surface is characterized by a north-south oriented submarine

Figure 4-3

canyon (less than 660 feet [200 meters] long), which divides Elliott Bay into the eastern (inner) and western (outer) bay. Elliott Bay is a very complicated system influenced by tidal motions, freshwater flow from the Duwamish River, wind stress, and boat travel (King County Metro 1995b). The natural flow consists of three layers: an upper layer of the bay flowing to the north, a lower layer flowing south, with a deeper third layer that follows bottom contours. This flow pattern is caused by the input of fresh water flowing into Elliott Bay and is described as estuarine circulation. Appendix F provides additional details of Elliott Bay water layers and currents.

Of potentially greatest interest to the Denny/Lake Union Project is recent monitoring information that indicates a pervasive net northerly flow pattern out of Elliott Bay from the northern inner half of the bay (Evans-Hamilton 1996). Additional oceanographic investigations are currently being conducted to further characterize flow patterns in Elliott Bay. Results of these investigations will be incorporated into ongoing analyses and evaluations.

4.3.3 Surface Water Quality

Additional discussion of water quality in Lake Union and Elliott Bay is included in the *Draft Water Quality Assessment* (King County Metro 1995b).

Water quality can be defined by many variables: water clarity, physical parameters (temperature, pH, dissolved oxygen), chemical content and composition, and the levels of bacteria and viruses. Water clarity and chemical composition of the water generally define productivity of the water body. The concentration of organic pollutants and metal concentrations are used to characterize effects from human-caused inputs. Fecal coliform bacteria are found in the large intestine of warm-blooded animals and are used as an indicator of fecal contamination. Common sources of fecal contamination are CSOs, stormwater discharges, domestic pets, and commercial and recreational vessels.

South Lake Union Subbasin. Lake Union has been designated as "Lake Class" (Appendix F, Table F-1). Lake Class bodies of water meet or exceed the regulations for Class AA Freshwater for swimming and fishing (Metro 1991). These standards state that the water quality “shall meet or exceed the requirements for all or substantially all” of the following uses: wildlife habitat; general recreation; fish reproduction, rearing and harvest; water supply; and stock watering. Appendix F provides details on Lake Union water quality variables.

Elliott Bay Subbasin. WAC 173-201A (Ecology 1992) designated outer Elliott Bay as "Class AA (Extraordinary)", and inner Elliott Bay as "Class A (Excellent)" (see Appendix F, Table F-1). The classification for inner Elliott Bay reflects the heavily developed nature of the waterfront, industry and commerce in and surrounding Seattle. Despite the high water quality standards, Ecology does not allow the harvest of shellfish or benthic algae in Elliott Bay's inner shoreline because of the potential for contamination (Metro 1994). Appendix F provides details on Elliott Bay water quality variables.

4.3.4 Groundwater Distribution and Flow

South Lake Union Subbasin. Detailed information on the quantity and quality of groundwater resources in the South Lake Union Subbasin is presently limited. Most groundwater in the subbasin is found perched on glacial till in sand and gravels associated with glacial outwash

deposits (Luzier 1963). Groundwater recharge in the subbasin is limited by the extensive coverage of pavement and buildings, and most recharge likely occurs on the ridges of Queen Anne Hill and Capital Hill (Seattle Office of Management and Planning 1995).

Groundwater generally flows toward the center of the subbasin where fill material is encountered. Groundwater flow is from east to west in the eastern portion of the subbasin (Capital Hill) and west to east in western portions of the subbasin (Queen Anne Hill). Once groundwater reaches the center of the subbasin it generally flows north toward Lake Union. Localized groundwater flow may differ from general flow patterns due to the numerous utility trenches crossing the subbasin. In these areas groundwater most likely flows through pervious backfilled trenches instead of through native soils. As a result, groundwater flow may be locally influenced and may not follow the topography and/or geology of the site in some areas (Seattle Office of Management and Planning 1995).

Information on groundwater depth is available from borings conducted for previously proposed development projects in the subbasin. Most borings indicate that groundwater is located at shallow depths throughout south Lake Union. Groundwater has been measured at a depth of 10 to 14 feet below the ground surface in the Mercer Street corridor as defined in the Seattle Commons EIS (Seattle Office of Management and Planning 1995). A search of the logs for borings drilled by the Seattle Engineering Department in the 1960's indicated that groundwater was encountered approximately 10 feet below the surface in most test borings along Westlake Avenue North and along Valley Street between Westlake Avenue North and Fairview Avenue North (Seattle Engineering Department 1994). Additional geotechnical studies will be performed in the vicinity of proposed facilities to further study groundwater and geologic conditions.

Elliott Bay Subbasin. Information on groundwater location and distribution is limited; however, based on studies conducted to date, it is likely that groundwater in the vicinity of Elliott Bay is tidally influenced and located at shallow depths. During initial geotechnical studies for the proposed project groundwater was encountered between 5 and 10 feet below the existing ground surface at the proposed Elliott West site (Hong West & Associates 1996b). Test borings performed in the vicinity of Elliott Avenue West and West Mercer Street indicated groundwater was encountered approximately 8 feet below the ground surface (Seattle Engineering Department 1986). Groundwater levels in the subbasin most likely fluctuate corresponding to Puget Sound tides (Hotchkiss et al. 1995).

4.3.5 Groundwater Quality

South Lake Union Subbasin. Groundwater quality in the South Lake Union Subbasin is affected by historical and current releases of contaminants into groundwater. In the Seattle Commons EIS (Seattle Office of Management and Planning 1995), over 290 known sites of underground storage tanks (USTs) were documented in the Commons planning area; approximately 50 of these sites have been documented as leaking underground storage tanks (LUSTs). Petroleum hydrocarbons are found in groundwater north of Mercer Street, between Westlake and Boren Avenues, and potentially in other locations in the subbasin. A major LUST of concern is the UNOCAL Station No. 5353, located at 600 Westlake Avenue North. A total of 800,000 gallons of leaded gasoline were released at this site in 1980. Approximately 400,000

gallons were recovered, but a product plume remains, bounded approximately by Westlake Avenue North, Valley Street, Mercer Street, and Terry Avenue North (Seattle Office of Management and Planning 1995).

Elliott Bay Subbasin. There has been no documentation of groundwater quality in the Elliott Bay Subbasin.

4.3.6 Historical and Current Sources of Pollution

There are inputs of point source and non-point source pollution into Elliott Bay and South Lake Union. A reduction in water quality can occur from surface runoff, runoff coming from storm drains and CSOs, accidental petroleum discharges from marine vessels, and industrial discharges. Municipal discharges (i.e., storm drains, CSOs, and wastewater treatment plants) collect much of the non-point source pollution. Further pollutant loading into the water column occurs from resuspension of contaminated sediments.

South Lake Union Subbasin. Lake Union has been a Seattle industrial hub for more than 100 years. Numerous industries have operated in and around the lake; these include a coal gasification plant, a power plant, several asphalt plants, lumber mills, sand/gravel/concrete producers, and shipbuilding. Current sources of pollution loading to Lake Union include industrial discharges, marina and boat wastes, CSOs, and stormwater. Lake Union has six stormwater basins and seven CSO basins that discharge directly into the lake (King County Metro 1995a). There are many public and private stormwater outfalls in the Lake Union and ship canal system. In addition, CSOs discharge approximately 100 million gallons (MG) per year into Lake Union (Brown and Caldwell and Metro 1992).

Elliott Bay Subbasin. Past sources of contaminants to Elliott Bay include intensive industrial activities and discharges, including releases in the north Harbor Island area. Potentially ongoing sources of pollutant loading to Elliott Bay include stormwater, CSOs, port activities, atmospheric deposition, industrial discharges, and the Duwamish River discharge (Tetra Tech 1988). There are currently many public and private stormwater outfalls discharging into Elliott Bay. Ten CSO outfalls discharge approximately 3,000 MG into Elliott Bay annually, three of which are operated by King County (Brown and Caldwell and Seattle Engineering Department 1988). In addition, the County operates three wastewater treatment plant outfalls which discharge immediately outside of Elliott Bay, located at Alki Point, West Point, and off Duwamish Head along the western boundary of outer Elliott Bay. The Alki primary treatment plant will be converted to a CSO treatment plant and wastewater flows will be transferred to King County's West Point Treatment Plant. Each discharge has been designed to comply with the State's "Effluent Dilution Zone Guidelines" (Ecology 1985), and the "Water Quality Standards for Surface Waters of the State of Washington" (Ecology 1992).

4.4 BIOLOGICAL RESOURCES

All correspondence regarding federal- or state-listed sensitive, threatened, or endangered species are included in Appendix G.

4.4.1 Plants and Wetlands

A database search of the Washington Natural Heritage Program (WNHP) Data System revealed no known occurrences of any federal- or state-listed sensitive, threatened, or endangered plant species in either subbasin (Norwood 1995). The City of Seattle (Seattle 1992) does not identify any sensitive habitats, including wetlands and riparian areas, in either subbasin.

South Lake Union Subbasin. In general, plant resources existing in the South Lake Union Subbasin are those typically found in urbanized, landscaped settings. Such plants include ornamental plantings, native and non-native grasses and weeds, and street trees planted by the City of Seattle. Weedy plant species, such as Himalayan blackberry (*Rubus discolor*), dandelion (*Taraxacum officinale*), and common tansy (*Tanacetum vulgare*) also occur in disturbed, unpaved areas.

Wetland-adapted plants occur within the project area along the shoreline in South Lake Union Park. Plant species found along the shoreline include giant horsetail (*Equisetum telmateia*), yellow iris (*Iris pseudocorus*), and white willow *(Salix alba*). Himalayan blackberry grows along the top of the bank on the shoreline. Lawn grasses occupy most of the remainder of South Lake Union Park.

Aquatic plants occur within Lake Union itself in nearshore and shallow water (littoral) habitats. Due to shoreline alteration, only a few small areas of shallow water habitat suitable to aquatic plants remain in the lake. Appendix H, Figure H-1 illustrates the location of these littoral habitats in Lake Union. Aquatic plant communities in the lake are typically dominated by invasive macrophytes such as coontail (*Ceratophyllum* sp.) and Eurasion water milfoil (*Myriophyllum spicatum*). Eurasian water milfoil is considered a nuisance species due to its invasive characteristics and ability to dominate native aquatic plant communities. Dense stands of milfoil can adversely affect navigation, recreation, and the ecological functioning of freshwater lakes, including fish habitat.

Elliott Bay Subbasin. Similar to the South Lake Union Subbasin, upland plant resources existing in most of the Elliott Bay Subbasin are typical to the urban environment. Ornamental plantings, as well as native and non-native grasses and weeds occupy disturbed, unpaved areas along roads. The Elliott West site is one of the few remaining open spaces within this portion of the project area. This site was formerly a lumber yard that burned down in 1989 and has since been left as a vacant lot. Plants occupying the Elliott West site are disturbance species, including Scot's broom (*Cytisus scoparius*) and Canada thistle (*Cirsium arvense*). Butterfly-bush (*Buddleja davidii*), an invasive ornamental shrub, is also common on the Elliott West site.

In addition to the Elliott West site, a small area of mixed deciduous and coniferous forest exists within the project area. This forested open space lies on a moderate slope immediately east of

Elliott Avenue West. Big-leaf maple (*Acer macrophyllum*) and Douglas-fir (*Pseudotsuga mensiezii*) are the dominant trees on the forested slope. Paper birch (*Betula papyrifera*) also occurs in this area. Trees are less than 30 feet in height, on average, and provide about 50 percent cover on the slope. The shrub layer is dense with Himalayan blackberry and Scot's broom as the dominant species. Herbaceous species include English ivy (*Hedera helix*) and western clematis. Residential structures are located midway up this slope and on the crest of the hill. Landscape shrubs and trees are found within the confines of Myrtle Edwards and Elliott Bay parks. These species are generally non-native and planted for their aesthetic value for park users.

Eelgrass and kelp beds are important plant communities found within the aquatic marine environment of Elliott Bay. Historically, the Elliott Bay nearshore environment supported extensive eelgrass and marsh habitat. However, recent estimates suggest that eelgrass/marsh habitat available in the bay is limited to a total of 50 acres (Stober and Pierson 1984). In the 1984 study, evaluations of Elliott Bay habitat indicated that an estimated 8 percent of habitat area is occupied by kelp beds and 4 percent by eelgrass with the remainder occupied by sand and mud (72 percent), riprap (6 percent), pilings (5 percent), and cobble/boulders (5 percent). Deep water habitat is primarily non-vegetated mud and sand bottom. Eelgrass is documented to occur near Alki and off West Point but has not been recorded along the Seattle downtown shoreline or along Myrtle Edwards Park (EVS Consultants 1995). Recent studies by the WDFW (Buckley 1996) for the Elliott Bay/Duwamish Restoration Program have identified eelgrass beds on Duwamish Head at depths of approximately 3 to 20 feet below MLLW.

According to the *Puget Sound Environmental Atlas,* major kelp beds are also not documented in the vicinity of this project. However, recent underwater surveys have been conducted by WDFW, as part of habitat restoration efforts for the Elliott Bay/Duwamish Restoration Program (Buckley and Bookheim 1996). Results from this survey indicate that common kelp (*Nereocystis leutekeana*) is present along with other macro-algae within nearshore habitats along Myrtle Edwards Park. Kelp is typically light limited and tends to occur in areas with a rocky substrate, such as riprap.

4.4.2 Wildlife

The City of Seattle (Seattle 1992) does not identify any sensitive habitats including urban wildlife habitat areas in either subbasin. A database search of the Washington Department of Fish and Wildlife's (WDFW) Priority Habitat and Species Data System and Non-game Data System was conducted for both subbasins in the Seattle South Quadrangle (WDFW 1995). No federal- or state-listed sensitive, threatened, or endangered wildlife species are listed within the data system for the project area. The U.S. Fish and Wildlife Service (USFWS) was also contacted in regards to sensitive species.

The South Lake Union and Elliott Bay subbasins are located in a highly urbanized landscape which is entirely developed in commercial and industrial land uses and lacks significant open spaces or wildlife habitat except for the shorelines of Lake Union and Elliott Bay. Dominant features of the terrestrial habitat available in these subbasins include roads, buildings, and parking lots, with boat docks along the shoreline. Wildlife species inhabiting this area are anticipated to be limited to those species exceptionally tolerant of human intrusion and development.

Marine and lake open water habitat is available for waterfowl species in the vicinity of the project. Canada goose, mallard, gadwall, and glacous-winged gull are most commonly observed on the lake year-round. Other seabirds and waterfowl use the bay and lake during the fall and winter months for wintering or during migratory stop-overs. These include American widgeon, bufflehead, greater and lesser scaup, Barrow's golden-eye, western grebe, cormorants, and hooded merganser. Duck species such as Barrow's golden-eye, bufflehead, widgeon, greater and lesser scaup, and mallard have been observed foraging in the Elliott Bay area. Gull species including glacous-winged gull, Bonaparte's gull, western gull, and California gull are also common along the rocky shoreline. The waterbodies are used primarily for foraging by these bird species, since nesting materials and cover are not adequately provided. In addition, the high volume of motorized boat and seaplane traffic further diminishes their use in providing valuable waterfowl habitat.

Other types of wildlife species which could use the limited greenways and open spaces in the project area include pigeon, starling, house sparrow, common crow, American robin, black-capped chickadees, and occasionally other songbirds. Small mammals such as deer mice, Townsend's vole, Norway rat, and opossum may inhabit urban open spaces within the project area. Due to the lack of natural habitat features, these animals are likely to find shelter in culverts, trash receptacles, and other incidental structures.

South Lake Union Subbasin. To the best of the present knowledge of the USFWS, no occurrences of federally-listed, proposed, or candidate wildlife species are documented in the project area within the South Lake Union Subbasin (USFWS 1994). However, bald eagles are known to occasionally use Lake Union as a forage area. No known eagle perch or nest sites have been documented or appear to be available in the south Lake Union area (WDFW 1995).

One 14-acre, city-owned park, South Lake Union Park, is located along the southern shoreline of Lake Union, north of Valley Street. South Lake Union Park provides grassy and shrub habitats for urban wildlife and undeveloped lake shoreline for waterfowl foraging. No other significant open space or natural areas occur within the immediate vicinity of the project.

Elliott Bay Subbasin. Although no known occurrences of federally-listed, proposed, or candidate wildlife species within the project area were revealed on the USFWS database search (USFWS 1996), concerns over possible impacts to marbled murrelet were noted (Frederick 1996). Marbled murrelet are discussed below in more detail. Also, peregrine falcon are known to occur within the vicinity of the Port of Seattle grain terminal, as documented by the Falcon Research Group (Deal and Muller 1994).

The shoreline park system, including Elliott Bay and Myrtle Edwards parks, located along the Elliott Bay waterfront at the boundary of this project, provides open space and wildlife habitat. No other designated Urban Natural Open Spaces have been recorded in the area on the Priority Habitat Species maps (WDFW 1995).

Bald eagles (*Haliaeetus leucocephalus*), peregrine falcon (*Falco peregrinus*), and marbled murrelet (*Brachyramphus marmoratus*) are federally-listed threatened and endangered species which have been observed foraging in the general vicinity of Elliott Bay. However, none of these

species have been documented with using habitats within the project vicinity except peregrine falcon. No known perch or nest sites have been documented or appear to be available in the Elliott Bay Subbasin for either bald eagle or marbled murrelet (WDFW 1995). Documented bald eagle nests occur on West Point in Discovery Park and on Duwamish Head above Salty's Restaurant (WDFW 1995). These eagles forage in large areas which include Elliott Bay, Lake Union, Lake Washington, and the Duwamish waterway.

Peregrine falcon routinely use the Port of Seattle grain terminal and piers for perching sites (Deal and Muller 1994). Peregrine falcon frequently feed on pigeons congregating along the Burlington Northern/Santa Fe Railroad tracks near the grain terminal. Since the falcon routinely uses urban environments within the City of Seattle for foraging, the USFWS does not require additional biological assessments of peregrine falcon for the Denny/Lake Union Project (Madrona 1996).

Marbled murrelets have been identified by the USFWS as a listed species which may occur in the vicinity of this project (Frederick 1996). Marbled murrelets are year-round residents of the Seattle area, mainly occurring in marine waters off Alki and West Point (Hunn 1982). No documented use of the Myrtle Edwards Park area by murrelets has been recorded. Eugene Hunn, author of *Birding in Seattle and King County* (1982) does not recall ever seeing marbled murrelets in the Seattle Harbor (Harris 1996). Marbled murrelets nest in old-growth or mature forests (WDW 1991), neither of which is available within the project vicinity. The WDFW Priority Habitat and Species Database (WDFW 1995) has not recorded marbled murrelets in the Seattle harbor area. The USFWS does not require additional biological assessment of marbled murrelets for the Denny/Lake Union Project (USFWS 1997).

Marine mammal haul outs for harbor seals and sea lions are located on Harbor Island at Duwamish Head and near West Point (King County Metro 1995b). Sea lion pups were observed by consultant staff on the beach at Myrtle Edwards Park in the spring of 1995. Steller sea lion, harbor seal, killer whale, and river otter have been observed in Elliott Bay. Dall's porpoise are present in the outer bay south of West Point; minke and gray whales may also occasionally visit Elliott Bay (King County Metro 1995b).

4.4.3 Fish and Shellfish

Figure H-2 in Appendix H illustrates fish habitat areas in Elliott Bay, the Lake Washington Ship Canal and the Duwamish Estuary. Shellfish resources are depicted in Figure H-3 in Appendix H.

South Lake Union Subbasin. Historically, the physical condition of Lake Union and the Lake Washington Basin was dramatically different from the current condition. The construction of the Lake Washington Ship Canal in 1916 connected Lake Union with Lake Washington to the east and Elliott Bay to the west. Thereafter, Lake Washington ceased to flow out of the Black River to the south, instead flowing to Elliott Bay via Lake Union and the ship canal. This project changed Lake Union from an isolated waterbody with only a small outlet stream into Elliott Bay, to a passage connecting two large waterbodies. The aquatic life, fisheries, and associated drainages in both Lake Union and Lake Washington were greatly changed. At the time, these changes were not well documented. In the context of these changes, anadromous fish runs were altered. Historically, there were runs of pink and chum salmon up the Cedar and Black Rivers, which flowed from Lake Washington

(Ames 1995). Currently, migrating salmonids access Lake Washington via the ship canal, as does an existing sockeye population, introduced in 1935.

At this time a variety of both anadromous salmonid and resident fishes have been listed as occurring in Lake Union (Appendix H, Table H-1). Anadromous salmonid species including sockeye, chinook, and coho salmon, and cutthroat and steelhead trout primarily use Lake Union as a migratory passageway. Resident warm water fishes including yellow perch, squawfish, largemouth bass, black crappie, and brown bullhead inhabit Lake Union throughout their life cycles. Adult salmon and many other resident fish within Lake Union prefer shallow water habitats for spawning and nursery habitat. Due to extensive alteration of the Lake Union shoreline, only a few small areas of littoral or shallow-water habitat are available for adult fish or juveniles (Metro 1993). One area is located at the north end of the lake along the shoreline of Gas Works Park. Two smaller areas are present in the southern end of the lake within the vicinity of the project area. Figure H-1 in Appendix H illustrates the general location of shallow water fish habitats within Lake Union and Elliott Bay.

Shellfish inhabiting Lake Union include crayfish which serve as a prey species for fish and are sometimes harvested recreationally (see Section 4.4.4). Current populations of crayfish within Lake Union have not been quantified.

CSO monitoring conducted by King County has indicated that CSOs frequently include constituents of concern to aquatic organisms, including toxic metals such as arsenic, copper, lead, zinc, and toxic organic constituents including petroleum products and plasticizers. These constituents can affect aquatic organisms through the water column as well as through sediments. Nearly all have been found to be toxic to fish at very low concentrations. Water quality and sediment modeling conducted as part of the *Draft Water Quality Assessment* (King County Metro 1995b) indicated that levels of several constituents in Lake Union water and sediments exceed recommended levels for protection of aquatic life. Resident freshwater species, both vertebrate and invertebrate, and juvenile anadromous salmonids are the species at potentially greatest risk from constituents in the water column.

Elliott Bay Subbasin. More than 100 fish species are known to use Elliott Bay. Species occurring in Elliott Bay include five species of salmon, two species of anadromous trout, and other species of marine fish and shellfish shown in Appendix H, Table H-2. The most abundant marine fish species include several species of sole, starry flounder, sculpin, perch, herring, hake, smelt, cod, and pollock.

Salmonid species use Elliott Bay as a migration corridor to the Duwamish River and upstream spawning habitat in the Green River basin. Nearshore waters of Elliott Bay and the mouth and lower intertidal reach of the Duwamish River have been identified as a particularly important nursery area.

Elliott Bay once provided extensive eel grass and kelp beds for aquatic habitat important to marine fish species. As discussed in Section 4.4.1 of this document, eel grass and kelp beds currently comprise less than an estimated 10 percent of aquatic habitat within Elliott Bay.

Chinook salmon, which are present in Elliott Bay, have been proposed by the National Marine Fisheries Service (NMFS) for listing as a threatened species under Section 7 of the Endangered Species Act. King County will continue to confer with NMFS to determine any potential impacts to chinook salmon resulting from the Denny Way/Lake Union CSO Control Project. Should chinook salmon become listed as a threatened species, it may be necessary for the County to investigate measures to reduce risk to salmon resulting from CSO discharges.

Shellfish identified in Elliott Bay include geoduck, clam, crab, and shrimp (see Appendix H, Table H-2). With the exception of shrimp, these populations are located primarily in outer Elliott Bay. Inner Elliott Bay has fewer species and lower abundance of invertebrate communities, corresponding with the elevated concentrations of conventional pollutants (see Section 4.4.6) and a substrate characterized by a high proportion of soft silt and silty sand. An approximately 190-acre geoduck clam bed has been surveyed between West Point and Fourmile Rock. This bed is closed due to discharge of sewage effluent from the West Point Treatment Plant (WDFW 1996). Non-harvestable quantities of geoducks may occur in other locations throughout Elliott Bay where substrate is suitable. Other hard-shell clam species are located along the shoreline between Duwamish Head and Alki Point, and at West Point. Both red rock and Dungeness crab occur in Elliott Bay; areas most important to these species lie between West Point and Smith Cove Park and just north of Alki Point (EVS Consultants 1995). Populations of shrimp have been identified in both inner and outer Elliott Bay (Dinnel et al. 1986).

Many contaminants of concern (e.g., copper, lead, mercury, PAHs) are expected to occur in the vicinity of the existing Denny Way CSO outfall (EVS Consultants 1995). Fish and invertebrate species currently using this area could be at risk from exposure to elevated concentrations of these contaminants. The species at greatest risk would be those which spend most of their life within the CSO outfall area or those species which use this habitat during sensitive life stages.

4.4.4 Recreational Fishery

Recreational fishery and shellfish resources in the South Lake Union and Elliott Bay subbasins are described below.

South Lake Union Subbasin. There is a sport fishery for resident warm water fish and salmonids in Lake Union. Recreational fishing is allowed year round for trout and other game fish (WDFW 1996). The Lake Union recreational fishery includes species such as perch and brown bullhead.

Anadromous salmon migrate to Lake Washington via the Lake Washington Ship Canal and Lake Union. Recreational seasons for salmon fishing are determined by the WDFW and are dependent on in-season abundance. In recent years, the Lake Union/Lake Washington fishing areas have been closed to salmon fishing (Pfeiffer 1996). Based on the 1992 Washington State Salmon and Steelhead Stock Inventory, there are resident Kokanee in Lake Washington and a once thriving sockeye population is now "depressed" (Wolf 1994). However, in 1996, an estimated run of

490,000 sockeye returned to the Lake Washington system, the largest run since 1988. Overall, the Lake Union fishery is relatively small.

In the past, crayfish have been harvested recreationally in Lake Union (Brown and Caldwell 1994). It is likely that some recreational harvest still occurs, however, no catch statistics are maintained by the WDFW.

Elliott Bay Subbasin. Elliott Bay is an important sport fishing area for salmon and other marine fish. Most recreational salmon fishing is concentrated on coho, chinook, chum, and sockeye. As previously stated, over 100 species of resident marine fish occur in the Elliott Bay and Duwamish Estuary (for a complete list see Stober and Pierson 1984); however, most of the fish catch is concentrated on a small portion of this total. Although anglers catch bottomfish, cod, perch and crab, salmon dominate the recreational harvest (King County Metro 1995b).

A sport fishing preserve is designated in Elliott Bay for the area defined by a line drawn between Terminal 91 and the Duwamish Head on the east and Fourmile Rock and Alki Point on the west (see Appendix H, Figure H-3); this area is avoided by commercial fishers during recreational harvest seasons (Hage 1996).

Recreational shellfishing is prohibited on all public beaches in Seattle (WAC 246-280). The Washington Department of Health has granted the Seattle-King County Department of Public Health the authority to enforce this statute (Plunkett 1997). However, due to the difficulty of enforcement, some recreational harvest does occur at Alki Point and West Point beaches. The frequency of recreational shellfish harvesting in the vicinity of Myrtle Edwards and Elliott Bay parks is unknown. However, because these shorelines do not provide readily accessible beach area, shellfishing activity is likely to be extremely low. A cooperative effort between the City of Seattle and King County to prevent recreational harvest of shellfish on Seattle public beaches is currently on-going. Measures such as increased signage on beaches, distribution of educational flyers, and monitoring by "beach stewards" are being implemented to emphasize the public health risks associated with consumption of shellfish. There is also a public health concern regarding marine bottomfish. Bottomfish taken from polluted urban bays (including Elliott Bay) have a higher prevalence of tumors and lesions (Tetra Tech 1988).

4.4.5 Commercial and Tribal Activity

South Lake Union Subbasin. Lake Union and the Lake Washington Ship Canal are designated as "usual and accustomed" fishing areas for the Point Elliott Treaty tribes and are currently fished exclusively by them. Non-tribal commercial fishing is not allowed within Lake Union or the ship canal (Appendix H, Figure H-3) (WDFW 1996). Currently, coho is the primary species harvested during a season lasting from mid-September through mid-October. Over the last four years, harvest of chinook has been phased out. The sockeye fishery was closed between 1988 and 1996. As described in Section 4.4.4, Recreational Fishery, an estimated run of 490,000 sockeye returned to the Lake Washington system in 1996 and an opening occurred between mid-July and mid-August of that year. Fishing seasons are determined cooperatively between the Muckleshoot Tribe and the WDFW. The majority of Lake Union salmon are harvested from the northern part

of Lake Union and the ship canal, however, adult coho and chinook salmon have been captured in south Lake Union (King County Metro 1995b).

Prior to 1986, crayfish were harvested from the ship canal, Portage Bay and Lake Union (Brown and Caldwell 1994). Crayfish have not been harvested commercially in Lake Union in recent years. Recent federal treaty interpretations have broadened the definition of "fish" to include shellfish. The Muckleshoot Tribe will consider the possibility of proceeding with commercial harvest in the future, depending on factors including abundance and market demand (Hage 1996).

Elliott Bay Subbasin. Non-tribal commercial fishing is prohibited in Elliott Bay. Elliott Bay is recognized as an "usual and accustomed" fishing/shellfish area for the Muckleshoot and Suquamish. The Elliott Bay commercial fishery is divided into two management areas (see Figure 4-3): management area 10A (bounded by a line from Terminal 91 to the Duwamish Head) is fished commercially by the Suquamish and Muckleshoot tribes; management area 10 proper, west of Area 10A and west of outer Elliott Bay, may be commercially fished by other treaty tribes in addition to the Muckleshoot and Suquamish tribes. Drifting gill nets are used for commercial fishing most of the time. Nets may be 40 to 115 feet (12 to 35 meters) below the surface depending on the targeted species and the location.

The commercial fishery in Elliott Bay is comprised mostly of salmon and steelhead. Chinook and coho are the two primary species of importance to the fishery (Hage 1996). When the stocks are abundant, the chinook season runs from July through the beginning of August with a typical catch of 1,000 to 10,000 fish. The coho season is from September through October with catches ranging from 5,000 to 30,000 fish. In addition to chinook and coho, there is a small (approximately 3,000 fish per season) chum fishery at the end of October (after the coho season). Approximately 200 to 2,000 steelhead are taken in December. A general trend of diminishing catch totals for steelhead has been observed in recent years (King County Metro 1995b), however, the Muckleshoot tribe has identified signs of recovery within the salmon fishery in recent years (Hage 1996).

The Muckleshoot and Suquamish Tribes jointly operate a net pen near Pier 86 (Grain Terminal), directly south of the large vessel loading dock (see Figure 4-3 and Appendix H, Figure H-5). The pen is 40 feet by 50 feet and 25 feet deep. In 1995, the net pens held 200,000 coho smolt from mid-March to mid-June. The release date of the coho is delayed in order to increase the likelihood that the salmon will remain in Puget Sound to mature. The tribes have the required permits to increase the net pen production to 1 million coho, which they plan to do in the near future (Hage 1996).

Commercial harvest of shellfish in Elliott Bay is prohibited by the Washington State Department of Health (WSDOH) due to pollutant discharges from wastewater outfalls and a variety of industrial and urban point and non-point sources.

4.4.6 Other Benthic Organisms

This section discusses benthic macroinvertebrates in the South Lake Union and Elliott Bay Subbasins, not including larger shellfish species, which were included within the above discussions.

South Lake Union Subbasin. Lake Union contains benthic (bottom-dwelling) macroinvertebrate communities typical of a deep, mesotrophic lake. Sixty-two macroinvertebrate taxa were identified during a 1993 study, with most of the total abundance composed of only a few species (Brown and Caldwell 1994). The benthic communities were found to be dominated by the annelid taxa; polychaete and oligochaete worms, and leeches. Insects, amphipods, isopods, and fingernail clams follow the annelids in abundance. Other benthic infaunal organisms found in Lake Union include flatworms, ribbon worms, midges, water mites, and crayfish. Crayfish (*Pacifasticus leniusculus*) are considered a particularly important resource because of their role as a prey species for fish.

Elliott Bay Subbasin. Studies of the macroinvertebrate communities within Elliott Bay indicate that the community shows signs of stress (Tetra Tech 1988; WDFW 1996). Relatively little natural beachfront remains, and therefore, little of the natural macroinvertebrate community exists in Elliott Bay. Much of the shorefront is composed of pier pilings and riprap. The steeply sloping riprap walls offer rocky intertidal benthic assemblages and some habitat for fish species, primarily perch, rockfish, greenling, and sculpin. Sessile organisms, such as mussels (*Mytilus edulus*), barnacles (*Balanus*) and anemones (*Metridium senile*) are common on wood or concrete pilings because of favorable attachment conditions.

Generally, the abundance and richness of benthic species tend to decrease with depth. Species richness tends to be highest near 200 foot of depth; abundance is highest at shallower depths (Stober and Chew 1984; Metro 1987b). Abundance and richness of species in inner Elliott Bay is dependent on a number of factors including substrate (fine silt/silty sand), amount of organic matter in sediments, salinity levels, and contaminants from industrial sources and CSO discharges. Monitoring studies for the Denny Way Sediment Cap Project have shown that the abundance, richness of species, and biomass has increased over three years from 1990 to 1992 in the vicinity of the sediment cap (Romberg et. al. 1995a)

4.5 ENERGY

In 1996, the Denny Regulator used 36,342 kilowatt hours of electricity for pumps, compressors, blowers, lighting, and other related facilities. Electricity is supplied by Seattle City Light.

4.6 ENVIRONMENTAL HEALTH

Public health risks can occur through the transmission of pathogens, which are present in CSOs, to receiving waters that are used for recreational purposes including swimming (limited in Elliott Bay due to cold water), scuba diving, wading, and fishing. Pathways for potential exposure include direct contact with contaminated water (e.g., swimming or wading), ingestion of pathogen-containing water, and/or ingestion of contaminated fish or shellfish. Pathogens of particular importance when considering CSOs include bacteria and viruses, which are present in untreated wastewater. Potentially toxic constituents (e.g., petroleum products, metals) that are transported in stormwater are also important when considering CSOs.

4.6.1 Bacteria and Viruses

The *Draft Water Quality Assessment* report (King County Metro 1995b) reviewed historical water and sediment quality data associated with stormwater, combined sewer overflows, and secondary effluent discharges. The report included Lake Union and Elliott Bay. A predictive model was developed to create water quality indices characterizing risk to human health and aquatic life from stormwater, CSOs, and secondary effluent discharges. These indices were developed using adopted human health and aquatic life criteria or guidelines. Indices greater than 1.0 indicate a potential risk.

Contaminants of concern identified for use in the model included: arsenic, cadmium, chromium, copper, lead, mercury, nickel, silver, zinc, benzoic acid, total PAHs, butylbenzyl phthalate, and *Dis* or *Bis* (2-ethylhexyl) phthalate. This list of contaminants was selected because they are typically found in stormwater and CSOs, persist in the environment, and are relatively toxic to aquatic biota and humans. Fecal coliform bacteria were also modeled and used to calculate human health indices. A complete discussion of the contaminant selection criteria, model methodology, and maps illustrating the indices can be found in the *Draft Water Quality Assessment* (King County Metro 1995b).

South Lake Union Subbasin. Bacterial loading to Lake Union is a potential environmental health concern because of the high amount of recreational use, including fishing and water contact activities, in the lake and along the shoreline. The Lake Union CSOs discharge approximately 80 - 100 million gallons of untreated CSOs into Lake Union annually. These flows have been determined to have levels of fecal coliform bacteria several orders of magnitude higher than water quality standards. Although fecal coliform bacteria are not disease-causing or pathogenic in themselves, they are presumed to indicate the potential presence of other disease-causing bacteria or viruses.

Human Health. The water quality indices calculated for human health in south Lake Union indicate that high potential health risks exist near the outfall of the Dexter Regulator, and along the northeastern portion of Lake Union near Portage Bay, in the vicinity of several Seattle stormwater outfalls.

Aquatic Organisms. The calculated water quality indices for aquatic organisms in south Lake Union indicate a minimal threat to aquatic organisms from CSO discharges.

Elliott Bay Subbasin. The Denny Way CSO overflows an estimated 50 times per year, discharging 300 - 600 million gallons of untreated combined sewage into Elliott Bay. Commercial harvesting of shellfish is not allowed in Elliott Bay because of high fecal coliform bacteria counts in the water and shellfish (King County Metro 1995b).

Human Health. Surface water quality indices were calculated for five depth layers in Elliott Bay. The two uppermost depth layers in the area closest to the shoreline of the Denny Regulator were evaluated, as this area represents the highest potential for human contact. The indices for human health are elevated and represent a potential human health risk. The elevated indices are likely due to high levels of fecal coliform bacteria.

Aquatic Organisms. The water quality indices for aquatic organisms in the uppermost surface water layers near the Denny Way CSO outfall indicate a moderate risk to aquatic organisms.

4.6.2 Hazardous Materials

Hazardous materials are those substances potentially toxic to humans, wildlife and other organisms. Hazardous substances that are potentially present in CSOs include: petroleum hydrocarbons, industrial and commercial chemicals, pesticides and herbicides, and metals (i.e., lead, arsenic, copper). Potential sources of hazardous materials include: roadway runoff, chemicals used by businesses and residential chemicals (i.e., solvents, paints, pesticides), and illicit dumping. Chemicals used by businesses and residences can be discharged into the sewer system which in turn can be discharged to a surface waterbody during a CSO event. Hazardous materials may also reach receiving waterbodies through illicit dumping into drains with direct surface water discharge.

Vehicular traffic deposits petroleum hydrocarbons and metals on local roadways; these substances are washed into the combined sewers during rainfall events. Because of the large amounts of impervious (e.g., paved) areas and high traffic volumes in both the South Lake Union and Denny Way drainage basins, roadway runoff likely contributes a significant source of toxic substances to Lake Union and Elliott Bay during CSO events.

4.7 NOISE

The human ear responds to a wide range of sound intensities. The decibel scale used to describe sound is a logarithmic rating system that accounts for the large differences in audible sound intensities. This scale accounts for the human perception of a doubling of loudness with an increase of 10 decibels (dBA). Hence, a 70 dBA sound level will sound twice as loud as a 60 dBA sound level. People generally cannot detect differences of 1 dBA; under ideal laboratory conditions, differences of 2 or 3 dBA can be detected. A five dBA change would be expected to be perceived under normal conditions. The table in Appendix I shows representative sounds and corresponding noise level produced in decibels.

When addressing the effects of noise on people, it is necessary to consider the frequency response of the human ear. Instruments are therefore designed to respond to or ignore certain frequencies. The frequency-weighting most often used is A-weighting; measurements from instruments using this system are reported in "A-weighted decibels" or dBA. All sounds in this discussion are reported in dBA. An indication of average sound levels is provided by a noise descriptor know as the equivalent sound level (Leq). The equivalent sound level is the level of a constant sound that has the same energy as the actual fluctuating sound. An Leq(24) measurement reflects the equivalent sound level for a 24 hour period; Leq(08) for an 8 hour period; etc.

Factors affecting the impact that a given noise will have on a person include frequency and duration of the noise, the absorbency of the ground and surroundings, and the distance of the receptor from the noise source. The receptor and the usual background noise levels also determine the degree of impact.

4.7.1 Regulatory Overview

Noise is regulated at the local level. Seattle has adopted a noise ordinance specifically regulating construction activities. Maximum permissible sound levels are established based upon the zoning of the noise source and the receiving property. Seattle Noise Ordinance stipulates that noise levels generated by industrially-zoned areas may not regularly exceed 60 dBA in residential areas, and 65 dBA in commercial areas. Table 4-2 summarizes maximum permissible noise levels for various land uses. These maximum permissible sound levels may be exceeded for construction between 7 a.m. and 10 p.m. on weekdays and between 9 a.m. and 10 p.m. on weekends. Appendix I describes representative sound levels of various sources including traffic and construction equipment.

Table 4-2
City of Seattle Maximum Permissible Noise Levels (dBA)

Zoning of Sound Source	Zoning of Receiving Property		
	Residential	Commercial	Industrial
Residential	55	57	60
Commercial	57	60	65
Industrial	60	65	70

Source: Seattle 1977.

4.7.2 Existing Noise Sources

South Lake Union Subbasin. Traffic sounds in the south Lake Union area are one of the major sources of noise. Measurements taken in 1994 for peak-hour traffic noise [Leq(1 hour)] levels in the south Lake Union area indicated levels of 69 dBA at the northeast corner of Valley Street and Westlake Avenue North and 66 dBA at South Lake Union Park and Valley Street (Seattle Office of Management and Planning 1995). Other major noise producing streets include Denny Way and Mercer Street.

Elliott Bay Subbasin. Traffic is the main source of noise in the Elliott Bay industrial and downtown Seattle areas, with less traffic noise in the more residential Queen Anne Hill area. Sound measurements taken in 1989 as part of the Central Waterfront Project (Port of Seattle 1989) indicate that permissible levels were exceeded at all locations. However, because the noise source was dominated by traffic, which is exempt from the noise ordinance, there was no violation. Measurement of sound levels taken on Alaskan Way in the Elliott Bay Subbasin area indicated an Leq (1 hour) of 65 dBA at the Edgewater Inn and an Leq (1 hour) of 73 dBA at the Seattle Aquarium (TRC Environmental Consultants 1991).

4.7.3 Noise Receptors

South Lake Union Subbasin. Potential receptors in south Lake Union include businesses, residences, and pedestrians. The southern tip of Lake Union is heavily used by shoppers, including several restaurants with outdoor seating during the summer. In addition, a large hotel is located along Fairview Avenue. Currently the highest concentration of noise-sensitive residential receptors exists in the Cascade neighborhood, the southwest Lake Union area (along Dexter

Avenue and Aurora Avenue), and the south Denny neighborhood east of Westlake Avenue. There are few residential receptors along the Mercer Street corridor. There are also sensitive receptors along the Lakeview Boulevard corridor.

Elliott Bay Subbasin. Noise receptors in this area include park users, especially Myrtle Edwards Park and Elliott Bay Park, and businesses along Elliott Avenue. Several condominiums are located along the western slope of Queen Anne Hill near the terminus of Mercer Street.

4.8 LAND AND SHORELINE USE

This section describes existing land and shoreline use in the South Lake Union and Elliott Bay Subbasins. Figure 4-4 is an aerial photograph with these subbasins outlined. Shoreline management policies and street rights-of-way information are also discussed. City of Seattle policies have been developed within the framework of state and regional policies. A summary of state, regional and City of Seattle land use planning policies, including those directly pertaining to public facilities and services, is included in Appendix J.

4.8.1 Existing and Future Land Use

Land use patterns in the South Lake Union and Elliott Bay subbasins typify urban levels of development and reflect historic land use patterns in Seattle. Figure 4-5 depicts existing land use patterns and zoning designations in the subbasin areas. The subbasins' surface area can be characterized as almost fully developed, and based on this characterization, future percent of impervious area is considered equal to current percent of impervious area.

The GMA and regional planning documents project some redevelopment to occur within Seattle. Future land use for the subbasin areas is dictated by the *City of Seattle Comprehensive Plan's* (Seattle 1994c) planning designations for and within urban and industrial growth centers (Figure 4-6). Zoning for the areas reflects the *Comprehensive Plan's* designations and is consistent with current development. Refer to Appendix J for additional discussion of the *Comprehensive Plan's* planning designations for neighborhood areas within the subbasins.

South Lake Union Subbasin. The South Lake Union Subbasin includes the existing south Lake Union area.

South Lake Union Area. Current development in the south Lake Union area is a combination of industrial, commercial, and residential uses. Warehouses, parking lots, and offices characterize most of the area. This portion of the project area encompasses the Cascade neighborhood, bounded on the west by Westlake Avenue North and on the east by Interstate 5. North and south boundaries are Mercer Street and Denny Way, respectively. The Cascade neighborhood includes a number of apartment buildings; it also provides the largest number of community services in the area, including two churches, two private schools, a day care center, and two homeless shelters (Seattle Office of Management and Planning 1995). Land use around the Lake Union shoreline is currently in transition from what was historically industrial manufacturing use to commercial use. New development includes office buildings, retail establishments, recreational marinas, South Lake

Union Park, and a small children's play area on the southwest corner of the lake. In addition, new residential development overlooking Lake Union is occurring along Dexter and Aurora avenues.

Figure 4-4

Figure 4-5

Figure 4-6

Elliott Bay Subbasin. The Elliott Bay Subbasin includes all or portions of several Seattle neighborhoods: Queen Anne, Seattle Center, Elliott Bay, and Downtown. Also within the subbasin is the Elliott Bay shoreline area north of Denny Way.

Queen Anne. Land use in the Queen Anne area is mostly residential. The Queen Anne Hill (Upper Queen Anne) neighborhood is predominantly single-family homes. Surrounding neighborhood residential use includes low- to mid-level apartment buildings and condominiums. There is a corridor of commercial use along Queen Anne Avenue North that serves the residents in the Queen Anne neighborhood.

Seattle Center. The Seattle Center area is bounded on the north by Mercer Street and on the south by Denny Way. It extends west to Elliott Avenue West, east to Broad Street and southeast to Fifth Avenue North. The Seattle Center is a 77-acre urban park with facilities catering to many diverse activities including sporting events, performing arts, and educational and cultural events. The park is designated for pedestrian use only. Directly west of the Seattle Center (an area typically referred to as Lower Queen Anne), is a mixture of commercial and high-density residential use. Offices and retail businesses mix proportionately with low- to mid-rise apartment buildings.

Elliott Bay. Land use along Elliott Bay from Elliott Avenue West, southeast along the waterfront to Bay Street, is predominantly commercial and light industrial. A minor residential component exists in the form of several multi-story apartment buildings along the side of the hill east of Elliott Avenue West, overlooking Elliott Bay. Two waterfront parks lie west of Elliott Avenue West: Myrtle Edwards Park to the south and Elliott Bay Park to the north. These two parks are described in Section 4.9, Parks and Recreation. Elliott Bay is an active port, with numerous terminals and port facilities. The Port of Seattle owns Pier 86 (Grain Terminal) located in Elliott Bay Park, and Terminal 91 located just north of Elliott Bay Park (see Figure 4-5). These facilities are described in Section 4.12.2, Waterborne Transportation.

Downtown. The City of Seattle downtown portion of the project area encompasses the Denny Regrade neighborhood, designated by Seattle as a "priority housing area" (Seattle Office for Long Range Planning 1985). Current land use in the Denny Regrade neighborhood is characterized by high-density office and residential buildings with ground floor retail use. Other land use is primarily commercial, characterized by mid- to high-level office buildings. Land use along the downtown waterfront consists of retail (Pier 70), office (Pier 69), and hotel (Pier 67). Pier 66 has recently undergone a redevelopment project (Central Waterfront Project) to accommodate a variety of uses including marine, commercial, hotel, and retail.

4.8.2 Shoreline Use

The Denny/Lake Union Project is being developed with the aid of a federal grant, and is therefore required to be consistent with the goals of the Coastal Zone Management Act of 1972 as amended (16 U.S.C. 1451 et seq.). In accordance with the Coastal Zone Management Act, the federal Coastal Zone Management Program (15 CFR 930) assures that “all federally-conducted or -supported activities...directly affecting the coastal zone are undertaken in a manner consistent to the maximum extent practicable with approved State coastal management programs” (15 CFR 930.30 Part C).

The City of Seattle Shoreline Master Program (1977) and subsequent implementation guidelines (1987), were developed in accordance the State Shoreline Management Act of 1971 (RCW 90.58).The SSMP regulates shoreline development with the purpose of protecting natural areas and systems, encouraging water-dependent uses, and providing the public visual and physical access to Seattle's shorelines and the water. The SSMP regulations overlay existing land use zones in the Shoreline District. Specifically, the SSMP regulates development on and within 200 feet of the shoreline and over water within the city limits (Seattle 1987; Seattle 1994b). The Shoreline Development guidelines for utilities (WAC 173-16-060(9)) include sewage facilities and require:

- Restoration of shoreline banks to pre-project configuration including replanting with native species and providing maintenance until new vegetation is established; and
- Selection of site location to avoid obstruction or destruction of scenic views and placing facilities underground where possible, and design for minimal damage to aesthetic qualities of the shoreline environment.

Two chapters of the *SSMP* apply to proposed CSO/wastewater facilities. *Chapter 23.60.152* (Seattle 1994b*)* lists general development standards applicable to all "environments," development, and uses. *Chapter 23.60.194* lists standards for intakes and outfalls. All of these standards focus on preserving shoreline character and mitigating any adverse impacts to the shoreline. The following standards are directly pertinent to the Denny/Lake Union project:

- Chapter 23.60.152B - "Solid and liquid wastes and untreated effluents shall not enter any bodies of water or be discharged onto the land."
- Chapter 23.60.152O - "Navigation channels shall be kept free of hazardous or obstructing development or uses."
- Chapter 23.60.194A - "All intakes and outfalls shall be located so they will not be visible at mean lower water."
- Chapter 23.60.194B - "All intakes and outfalls shall be designed and constructed to prevent the entry of fish."

The *SSMP* divides Seattle's shorelines into different environments to facilitate the goals and objectives associated with each area. Purpose and uses for the shoreline environments are defined in Appendix K as per *Resolution 27618* (Seattle 1987) and *Chapter 23.60* of the *SSMP* (Seattle 1994b). Shoreline environment designations for the South Lake Union and Elliott Bay shoreline areas are identified below and are also shown in Appendix K (Figures K-1 and K-2)

South Lake Union Subbasin. The South Lake Union Subbasin includes the following shoreline environments: Conservancy Navigation (CN), Conservancy Management (CM), Conservancy Waterway (CW), and Urban Stable (US).

Elliott Bay Subbasin. The Elliott Bay Subbasin includes the following shoreline environments: Urban Industrial (UI); Urban Stable (US); Urban General (UG), Conservancy Management (CM), and Conservancy Natural (CN). South of Bay Street, the shoreline environment changes to Urban Harborfront (UH). The Elliott West site, located at the intersection of West Mercer Street and Elliott Avenue West is located just outside the 200 foot shoreline district boundary within the Elliott Bay Subbasin.

4.8.3 Street Rights-of-Way

Public street-related lands (rights-of-way) in the City of Seattle are dedicated in perpetuity for use by the residents of Seattle and others for purposes of public travel and transportation of goods (City of Seattle Resolution 28605 and Seattle Street Vacation Policies). Rights-of-way may be acquired for private use through a process known as "Street Vacation." Street Vacation decisions in Seattle are City Council decisions as provided by State statute. A Street Vacation is generally initiated by petition and will only be approved if the Council determines that the Vacation would be in the public interest. In making this decision, the Council weighs the following three public interest components:

- Protection of the public trust. The impact of the proposed vacation upon access, circulation, utilities, light, air, open space and views provided by the right-of-way.
- Protection from adverse land use effects. The land use impact of the proposed vacation (e.g., potential development involving the vacated right-of-way) must be consistent with city land use policies for the area in which the right-of-way is located.
- Provision of public benefit. Benefits accruing to the public from the vacation of the right-of-way. Proposed vacations may be approved only when they provide a long-term public benefit.

The improved West Mercer Street terminates at the top of Queen Anne Hill where Mercer Street veers north into West Mercer Place. The public right-of-way for West Mercer Street extends across the Elliott West site from Elliott Avenue West to the railroad right-of-way (see Figure 3-3). The right-of-way encompasses approximately 22,736 sq. ft. (2,112 sq. meters) or 0.522 acres on the Elliott West site. The location of the railroad tracks prevents the extension of West Mercer Street through to Myrtle Edwards Park.

4.9 RECREATION

This section describes parks and other recreational resources within or immediately adjacent to the Denny/Lake Union project area (Figure 4-7). Bicycle routes are discussed in Section 4.12.1 Existing Roadway Network. Recreational boating is discussed in Section 4.12.2 Waterborne Transportation.

Seattle's Park and Recreation COMPLAN (COMPLAN) (Seattle Parks and Recreation Department 1993) addresses open space, park, and recreation services over the next 10 to 20 years for Seattle parks. Goals defined in the *COMPLAN* for Seattle's park and recreation system focus on providing an interconnected park system, closely linked to communities, which guarantees accessibility to all members of the general public. The *COMPLAN* includes inventories of existing park and recreational resources and provides guidelines for future improvements and acquisitions. Future improvements planned for parks in the Denny/Lake Union CSO Subbasins are discussed below.

South Lake Union Subbasin. Within the South Lake Union Subbasin are three existing parks which are discussed below and shown on Figure 4-7.

Denny Park is a city-owned five acre park bounded on the north by West John Street and the south by Denny Way. East and west boundaries are Dexter Avenue and 9th Avenue North, respectively. Denny Park features benches, broad pathways, tall trees, and a grassy lawn. Denny

Park is used exclusively for passive recreation such as sitting, walking, or picnicking. The Seattle Parks Department headquarters are located at the west end of the park.

South Lake Union Park is an approximately 14 acre, city-owned park, located at Terry Avenue North and Valley Street at the south tip of Lake Union. The park includes the Maritime Heritage Center (the Center for Wooden Boats and Northwest Seaport). The open grass section of the park offers picnic tables and benches overlooking Lake Union. Public access to the lake for small crafts is available at the Center for Wooden Boats. Other urban waterfront activities offered by the Center for Wooden Boats include a small craft museum, boat rental, and sailing instruction.

The Cascade Playground is a 1.7 acre, city-owned neighborhood park, bounded on the north by Harrison Street and on the east and west by Pontius Avenue North and Minor Avenue North, respectively. The playground offers one swing set, one children's play structure, and one ballfield. Two daycare centers are located nearby and use the playground regularly. The ballfield is often used by workers in the area.

Elliott Bay Subbasin. Within the Elliott Bay Subbasin are six existing parks which are discussed below and shown on Figure 4-7.

Myrtle Edwards Park and Elliott Bay Park. Myrtle Edwards Park is a city-owned 3.7 acre stretch of park beginning at the parking lot adjacent to Pier 70 and extending along the shoreline to West Thomas Street. Elliott Bay Park**,** owned and maintained by the Port of Seattle, consists of 10.5 acres and extends from West Thomas Street to Terminal 91. Two separated 1.25 mile paths for bicycles and pedestrians extend the length of the interconnected parks. The parks include a grassy lawn, a shoreline built up with large boulders, and offer numerous benches facing Elliott Bay. A small amount of sandy beach area is accessible to the public. Myrtle Edwards and Elliott Bay parks are heavily used by the public throughout the year, but particularly during warm, sunny days. Recreational use in these two parks includes walking, jogging, rollerskating, sitting, and kite flying. The *COMPLAN* has identified Myrtle Edwards as a future site for a children's play area and as a candidate for beach and picnic improvements. The popular park has generated a dedicated following (i.e., "Friends of Myrtle Edwards Beach", a public interest group concerned with the use and fate of the park). The Department of Parks and Recreation Planning Division has requested State Park Improvement Funds (SPIF) for central access over the railroad tracks in the vicinity of the street end at West Thomas Street.

The Elliott Bay Fishing Pier is a 400 foot pier located just north of Pier 86 (Grain Terminal) in Elliott Bay Park. This pier, owned and maintained by the Port of Seattle, offers tables, benches, shelters, and fish cleaning stations. Bait, tackle, and concessions are available seasonally at a small kiosk located at the head of the pier. The Elliott Bay Fishing Pier is regularly used by local area fisherman year round.

Figure 4-7

Kinnear Park is a 14 acre park on the western slope of Queen Anne Hill. Kinnear Park has large grassy areas encircled by trees, benches, and broad pathways. A tennis court is located on the east end of the park. The park overlooks Elliott Bay and offers an encompassing view of Pier 86 (Grain Terminal). Kinnear Park is mostly oriented toward passive recreational use.

The Seattle Center is a 77 acre urban park on lower Queen Anne Hill visited by millions of people every year. The Seattle Center includes 20 acres of open space, as well as the Space Needle, Pacific Science Center, numerous stadiums and theaters, and an amusement park. A future bicycle/pedestrian trail connecting the Seattle Center with Lake Union is identified in the *COMPLAN* as a "priority Boulevard and Trail project."

Smith Cove Park is a 0.4 acre park, owned and maintained by the Port of Seattle, located just west of Terminal 91. This small park offers 500 feet of shoreline, picnic tables, and grassy areas. A bicycle path parallels the park's access road.

4.10 AESTHETICS

This section describes views within the subbasins tributary to the Denny Way CSO: South Lake Union and Elliott Bay. Specific views from the Elliott West site are also described.

The South Lake Union and Elliott Bay Subbasins are highly urbanized, as described in the Land Use section (refer to Figures 4-5 and 4-6). Development is mostly medium to high density commercial. Views in the area are dominated by the surrounding physical features, including the Olympic and Cascade Mountain ranges, and water bodies including Puget Sound, Lake Union, and Lake Washington. Much of the area's development has been oriented to take advantage of the scenic nature of this area.

South Lake Union Subbasin. The southern end of Lake Union offers views of the highly developed Lake Union shoreline, downtown Seattle, and the surrounding commercial land uses. Figure 4-8 shows the view north across Lake Union from the visitor kiosk at the Maritime Heritage Center located at the south end of the lake. Looking southwest from South Lake Union Park, the view offers a clear view of the Denny Regrade area (Figure 4-9).

Elliott Bay Subbasin. The Seattle Center urban park dominates the viewscape on lower Queen Anne Hill. The 605 foot Space Needle, located on the south side of the Seattle Center, provides a visual focal point for both the South Lake Union and Elliott Bay Subbasins. Views to the south from Queen Anne Hill include Elliott Bay, downtown Seattle, and Mount Rainier. The Downtown Waterfront extends along the eastern shoreline of Elliott Bay. Elliott Bay is a working harbor, with many large container ships in the harbor at any given time.

The western slope of Queen Anne Hill provides an expansive view of Elliott Bay, southern Puget Sound, and the Olympic mountain range. Several condominium buildings overlook Elliott Bay from the hillside above Elliott Avenue West. Pier 86 (the Grain Terminal) dominates the local shoreline (Figure 4-10). From Elliott Avenue West, the view to the west is frequently dominated by train cars; the Burlington Northern tracks between Elliott Avenue West and Myrtle Edwards

Figures 4-8 & 4-9

Figures 4-10 & 4-11

and Elliott Bay Parks are often lined with train cars, which block the low-level view of the park and shoreline from Elliott Avenue West. Similarly, these train cars often block the low-level view eastward from Myrtle Edwards Park toward Elliott Avenue West and Queen Anne Hill.

The Elliott West site is located on the west side of Elliott Avenue West at West Mercer Street near the Grain Terminal (Figure 4-11). The west side of the property abuts the railroad tracks separating Elliott Avenue West from Elliott Bay and Myrtle Edwards parks. As previously described, parked trains preclude any view of the water or parks from the site. The Elliott West site is bordered on the north by Darigold's main office and on the south by a warehouse and screen printing/graphics shop. Along the east side of Elliott Avenue West, across from the Elliott West site, is a commercial area, which includes a service station, restaurants, a new condominium project, and an empty warehouse.

4.11 HISTORICAL AND CULTURAL PRESERVATION

The cultural resources affected environment was determined through a cultural resource overview of the project area which consisted of a literature review and records search, and consultation with individuals and agencies. State and City of Seattle agencies responsible for maintaining records and inventories of historic properties were consulted to locate recorded archaeological sites and historic structures within the project area, and to determine their evaluation status. Historic properties in the project area were identified through examination of Washington State Office of Archaeology and Historic Preservation (OAHP) archaeological site inventory records; Seattle Landmarks field inventory forms; and federal, state, and local registers, including the National Register of Historic Places, Washington Heritage Register, and Seattle City Landmarks. Background cultural information was obtained from ethnographies, records of court proceedings, local histories, historic maps, previous cultural resource studies, and scientific research reports.

Portions of the Denny/Lake Union Project area have a high probability for hunter-fisher-gatherer and/or historic archaeological resources, especially the old Elliott Bay shoreline and the old shoreline of Lake Union. The Elliott Bay shoreline was used by hunter-fisher-gatherers for dwellings and seasonal camps as well as for fishing and digging shellfish. Archaeological remains of ethnographic and historic Indian lifeways, subsistence, and settlement may be preserved under fill along the old Elliott Bay shoreline. Historic archaeological deposits on and adjacent to the old Elliott Bay shoreline also may be covered with fill, including evidence relating to early settlers, roads, streetcar lines, and businesses. The south end of Lake Union was the location of a hunter-fisher-gatherer village and camping area as well as early historic period dwellings, roads, railroads, and sawmills. Also, as may be expected, historic structures associated with different stages of Seattle’s development are numerous throughout both the South Lake Union and Elliott Bay subbasins.

4.11.1 Historic Structures

Over two hundred historic structures and historic properties are in or adjacent to the Denny/Lake Union Project area. Many are listed on the National Register of Historic Places (NRHP); Washington Heritage Register (WHR), formerly the State Register of Historic Places; have been designated Seattle City Landmarks (SCL); or meet the criteria for more than one designation. Other structures have not been evaluated but may be eligible for one or more designation.

4.11.2 Archaeological Resources

Hunter-fisher-gatherer and historic archaeological resources are buried resources, in contrast to aboveground structures. Hunter-fisher-gatherer archaeological resources consist of the remains of occupations of people inhabiting the Seattle area prior to contact with Euroamericans and may include base camps, seasonal camps, villages, sweat lodges, burials, and cemeteries. Buried features may consist of fire hearths, cooking pits, rock pavements for drying clams, fish racks, postmolds from structures, and artifacts. Historic archaeological deposits may reflect historic Indian occupations, early Euroamerican settlement, and the settlement of different ethnic groups in Seattle (Figure 4-12).

South Lake Union Subbasin. No hunter-fisher-gatherer or historic archaeological sites have been identified in the South Lake Union Subbasin. One project, the Downtown Seattle Transit Tunnel Project was conducted in 1985 and included the southern portion of the South Lake Union Subbasin (Hart-Crowser and Associates 1986a, 1986b). No cultural resources were identified as part of that project, but analysis of data from borings of the Pine Street profile suggested that modifications to elevations of the original ground surface of Pine Street included grading and the placement of fill after the turn of the century. Early street grades were probably buried in the project area, and may have associated historic archaeological evidence. Historic archaeological deposits which may be expected in the Lake Union Subbasin may include evidence of early sawmills, transportation related features, early businesses and farmsteads. Historic refuse filling the south end of Lake Union may be from an early city dump or was used to fill the shoreline. Some occupations may be associated with ethnic groups like the Chinese, Russian and Scandinavian communities who settled on South Lake Union.

Elliott Bay Subbasin. No hunter-fisher-gatherer resources have been identified in the Elliott Bay Subbasin and no archaeological studies have been conducted in this area. However, the Elliott Bay shoreline which was filled during the historic period may also be the location of early hunter-fisher-gatherer campsites that have been protected by the fill. Historic archaeological deposits in the Elliott Bay Subbasin may include evidence of Seattle's earliest settlers, early transportation features like roads and street car lines, and the diverse and evolving parade of businesses that occupied the Elliott Bay shoreline.

4.12 TRANSPORTATION

This section describes the existing street, marine, and rail transportation network in the vicinity of Elliott Bay and South Lake Union Subbasins. The areas that may be affected by project construction include some of the most heavily used transportation networks in Seattle. Interstate 5, running north-south, skirts the eastern edge of the south Lake Union area and State Route 99, the western edge. The South Lake Union Subbasin is connected to the Elliott Bay Subbasin by Mercer Street and Denny Way, which run east-west. These areas are especially congested due to their access to limited entry points on Interstate 5. Elliott Avenue parallels Elliott Bay and is a major route for truck traffic to and from the area's ports, resulting in steady traffic throughout the day.

Figure 4-12

4.12.1 Existing Roadway Network

The street classification system defines how streets should be used by general traffic, the traffic volume, and the type of travel (local access or bypass). The functional street classifications are important for traffic regulation and enforcement, speed limits, intersection controls (i.e., stop signs, traffic circles, lights), and parking. Appendix N includes explanations of terms and classification tables for major streets in the south Lake Union and Elliott Bay areas.

Level of service (LOS) is a measure developed to quantify the degree of ease with which motorists travel through a given intersection or roadway segment. The degree of comfort includes such elements as travel time, number of stops, total amount of stopped delay, and impediments caused by other vehicles. Six degrees of service are used to denote the LOS. They range from A (the best traffic condition with little or no delay) to F (representing extreme congestion).

South Lake Union Subbasin. The south Lake Union transportation system is bounded by SR 99 (Aurora Avenue North) on the west; 7th Avenue, Virginia Street, and Denny Way to the south; Melrose Avenue to the east; and Republican Street and Westlake Avenue to the north. Mercer Avenue and Denny Way are major east-west corridors from Elliott Bay and downtown to Interstate 5. The functional classification and truck classification for major streets in the south Lake Union area are summarized in Appendix N, Table N-1. A summary of surface street characteristics in the South Lake Union area is located in Appendix N, Table N-2. Traffic volumes for this area are summarized in Appendix O, Tables O-1 and O-2.

Traffic Volumes and Level of Service. The South Lake Union Subbasin, because of its location between I-5 and SR 99, is a heavily traveled area. Mercer Street and Denny Way provide the two major east-west connections between the highways. The daily volumes range from less than 13,000 vehicles per day (vpd) on Virginia Street to nearly 110,000 vpd on West Mercer Street (from Fairview Avenue North to 9th Avenue North). Traffic volumes on Interstate 5 south of the SR 520 Interchange averaged approximately 225,000 per day in 1997 (WDOT 1997).

Most of the streets in the south Lake Union area currently experience delay. Table N-3 in Appendix N summarizes LOS on major roadways in the South Lake Union Subbasin. Congested conditions (LOS E or F) are typical in the south Lake Union area along the Mercer and Denny Way corridors during peak traffic hours (Table 4-3). As part of the *Seattle Commons/South Lake Union EIS* (Seattle Office of Management and Planning 1995) fifteen intersections were analyzed for LOS during the evening peak hours and seven for LOS during morning peak hours.

Congested conditions frequently result in high accident rates; several South Lake Union Subbasin streets have frequent accidents (Appendix N, Table N-4). Fairview Avenue North had the highest accident rates during 1994 in the south Lake Union area at the intersections with Mercer Street and Valley Street.

Transit. King County operates several transit routes in the south Lake Union area with several buses per hour. There are two bus routes operating on Fairview Avenue North, four routes on Westlake Avenue North and one route on Virginia Street. Appendix N, Table N-2 summarizes and details route information.

Table 4-3
LOS Designations At Select Intersections In South Lake Union

	Evening Peak Hours	Morning Peak Hours
LOS E Intersections	Denny Way & Fairview Ave	Valley/Broad/Westlake
LOS F Intersections	Denny Way & Stewart St	Mercer St & Fairview Ave
	Mercer St & Westlake Ave	
	Mercer St & Fairview Av	

Pedestrian and Bicycle Facilities. The area around Lake Union, especially the south end, is a popular bicycle and pedestrian route. Pedestrian and bicycle facilities are found on the majority of arterials in the south Lake Union area. Designated bicycle routes in Seattle include paths, lanes, arterial routes, and residential routes (Lagerway 1994). Bicycle paths and lanes are separated from the main flow of vehicular traffic whereas arterial and residential routes share existing streets with traffic. In the south Lake Union area there is a bicycle lane on Dexter Avenue North which runs along the west side of Lake Union, crossing Denny Way and continuing into the downtown area. Possible bicycle and pedestrian circulation additions by the City of Seattle include: a West Lake Union Trail from the Fremont Bridge to the south end of Lake Union; a new bicycle route from the Eastlake area to the central business district on Terry Avenue; a new bicycle and pedestrian connection between south Lake Union and the Seattle Center; and a multi-purpose trail along the south and west sides of Lake Union.

Elliott Bay Subbasin. The Elliott Bay/Queen Anne surface transportation system is bounded by Elliott Avenue to the west; Virginia Street to the south; 4th, 5th, and 1st Avenues to the east; and Crockett Street to the north. Elliott Avenue runs north-south along Elliott Bay, eventually connecting with the Alaskan Way viaduct (State Route 99) near Blanchard Street downtown. Mercer Street and Denny Way connect the Elliott Bay system to the south Lake Union system and Interstate 5 and State Route 99. Most of this system receives very heavy traffic and is congested throughout much of the day, particularly during peak travel periods. The Queen Anne Hill residential area north of Mercer is less congested. Functional classifications of streets in this area include principal, collector, and minor arterials. There are seven principal arterials, the largest classification category aside from regional arterials. All streets in the Elliott Bay/Queen Anne area are classified as truck streets with the exception of Elliott Avenue which is a larger truck route.

The functional and truck classifications for major streets in the Elliott Bay/Queen Anne area are presented in Appendix N, Table N-5. A summary of surface street characteristics in the Elliott Bay area is located in Appendix N, Table N-6. Traffic volumes for this area are summarized in Appendix O, Table O-2.

Traffic Volumes and Level of Service. The Elliott Bay/Queen Anne area, in the vicinity of downtown, is one of the busiest traffic areas in Seattle. Elliott Avenue is also the major north-south traffic and truck route on the west side of Seattle, connecting the highly industrialized areas from Duwamish north to Ballard. Queen Anne Avenue is a major street connecting Queen Anne Hill with Mercer Street and other east-west corridors. The daily volumes range from

approximately 26,000 vpd on 4th Avenue to over 123,000 vpd on Denny Way. Other street sections in the Elliott Bay area carry around 100,000 vpd including Elliott Avenue, Western Avenue, Broad Street, and Alaskan Way.

Heavily traveled streets experience congestion and delays resulting in LOS as low as F on Elliott Avenue near Broad Street. Congestion is somewhat less near the intersection of Denny Way and Broad Street, however, none of the area's intersections are free-flowing (LOS A). Table N-7 in Appendix N summarizes LOS on the major roadways in the Elliott Bay Subbasin. Annual accident statistics (Burns 1994) indicate that the intersection of Mercer Street and Queen Anne Avenue North is a higher accident area. Several accidents have also been recorded for the intersections of 2nd Avenue and Denny Way, and Western Avenue and Denny Way.

Transit. King County operates thirteen transit routes which serve the major streets of Elliott Bay and Queen Anne Hill. Appendix N, Table N-6 summarizes and details route information.

Pedestrian and Bicycle Facilities. The bicycle and pedestrian routes in the Elliott Bay area are dominated by the waterfront bicycle path which runs from near Piers 90 and 91 in Elliott Bay Park south through Myrtle Edwards Park to near Pier 70. There are bicycle arterial routes (combined motor vehicle/bicycle streets) as well as residential bicycle routes throughout the area. The City of Seattle recently added a bike lane on the east side of Second Avenue.

West Point Treatment Plant. Currently, about 2500 biosolids truck trips (roundtrips) occur annually. this is about 213 roundtrips per month to take the biosolids off site. The route is through Discovery Park to Gilman Avenue West, the Drago Street to 15th Avenue West to Denny Way and on to I-5.

4.12.2 Waterborne Transportation

South Lake Union Subbasin. Lake Union is extensively used as a recreational boating center with some industrial usage, such as the Lake Union Dry Dock.

Recreational Boating. Lake Union is highly used by sail boats, row boats, canoes, kayaks, and power boats. There are numerous marinas around the lake perimeter. Weekly sailboat races occur during the spring, summer and fall. Approximately four boat rental centers on the lake operate throughout the year including the Center for Wooden Boats on south Lake Union. The Center has approximately 140 sailboats and rowboats for rental.

Air Transportation. Lake Union is also used by Kenmore Air for landings and takeoffs in float planes. These planes are dependent on water.

Elliott Bay Subbasin. Harbor facilities in Elliott Bay are extensive and support a wide variety of commercial traffic including cargo vessels, local and international ferry vessels, and pleasure boats. The commercial cargo vessels link Seattle with the Pacific Rim and Alaska.

Commercial Vessels. In Elliott Bay, large commercial vessels use the major berthing areas located at Terminals 91 and 86. Commercial traffic to Terminal 91 (Pier 90 and 91) includes a wide

variety of cargo vessels, commercial fishing vessels, tugs, barges, and naval vessels. Figure 4-13 illustrates marine terminals in Elliott Bay. Commercial vessel traffic from Terminal 91 is served by tugs, which are used as escorts from within Elliott Bay. Port vessel call records show that 83 vessels entered and departed Terminal 91 in 1993. Approximately 53 percent of those entries were automotive imports. These figures are representative of large vessels and exclude smaller daily traffic to the Terminal. Terminal 86 is operated by Cargill, Inc. for the Port of Seattle and is used heavily for grain exports. Port vessel call records for 1993 show 47 ships entering and departing from Terminal 86. Vessels awaiting service at this Terminal may anchor within the designated anchorage area in Elliott Bay (see Figure 4-13).

Ferry Traffic. The Washington State Department of Transportation (WSDOT) provides regularly scheduled ferry service between Seattle and Bremerton (approximately 20 trips per day) and between Seattle and Bainbridge Island (approximately 24 trips per day).

Recreational Boating. Elliott Bay and the Duwamish River provide several recreational boating facilities. Much of the recreational boating traffic is concentrated near the Duwamish River and Harbor Island, in southern Elliott Bay. The Elliott Bay Marina, constructed in the early 1990's at the base of Magnolia Bluff, has increased recreational boat traffic in northern Elliott Bay. This 78-acre marina provides moorage for approximately 1,200 boats. A new central waterfront marina has also been added. For transient recreational moorage, Seattle provides a small marina with upland facilities at Seacrest as part of the shoreline park facility. However, a much larger boat launch facility is located at Don Armeni Park near Duwamish Head. During the fishing season this facility receives particularly heavy use.

4.12.3 Rail Transportation

Burlington Northern/Santa Fe Railroad (BNSFRR) and Union Pacific Railroad (UPRR) own and operate rail lines throughout the Seattle area including areas potentially affected by the Denny/Lake Union project. The Port of Seattle also has rail lines near the Grain Terminal.

South Lake Union Subbasin. The south Lake Union area is less developed than Elliott Bay in terms of rail traffic. BNSFRR had a rail line the entire length of Lake Union, inside of Westlake Avenue, and approximately half way up the east side, but this line has been abandoned.

Elliott Bay Subbasin. The Elliott Bay waterfront area has an intricate and highly used rail transportation system (see Figure 4-13). Access to shipping piers and other waterfront facilities has produced an infrastructure of rail lines spanning the entire waterfront with a major rail yard located in the Interbay area north of Elliott Bay and Terminal 91. The Interbay area refers to the area between northern Elliott Bay and the western portion of the ship canal.

Balmer Yard System. Balmer Yard is the main BNSFRR rail yard located east of Terminal 91 in Interbay. Much of the north-south rail traffic passes through this yard. Double tracks start at Pier 69 and run north through Balmer Yard. Balmer Yard contains approximately 30 sets of tracks

Figure 4-13

and may accommodate 60 to 70 trains per day with over 100 rail cars per train (Hague 1995). The peak train activity hours on the BNSFRR lines is between 6:30 p.m. and 2 a.m.

Trolley System. King County owns and operates a waterfront trolley system which has regularly scheduled trips from north of Broad Street to south of Jackson Street. The trolley tracks are adjacent to and west of BNSFRR Tracks.

Amtrak. Amtrak trains operate on BNSFRR rail lines and depart from the King Street Station in Pioneer Square. Two scheduled trips pass through the Elliott Bay Subbasin: a daily roundtrip Seattle to Vancouver, B.C., and a Seattle to Chicago trip four days a week.

Commuter Rail. The Regional Transit Authority is currently working on a regional transportation plan. The plan includes a commuter rail line on existing and new rails. Details on routes has not been determined.

Light Rail. The Regional Transit Authority is currently pursuing pre-design for a light rail line between the University District and Sea Tac through downtown Seattle. The preferred route is under Capitol Hill. An alternative is to the Seattle Center then through downtown Seattle.

4.13 PUBLIC UTILITIES AND SERVICES

The highly-developed areas within the Lake Union and Elliott Bay Subbasins are the location of numerous public utilities and services as described below.

4.13.1 Electricity

Electrical energy is supplied to the South Lake Union and Elliott Bay Subbasins by Seattle City Light (SCL). SCL is a city-owned electric utility serving approximately 131 square miles, including all of Seattle and some portions of King County north and south of the city limits. A major substation, the Broad Street Substation, is located within the South Lake Union Subbasin at 319 Sixth Avenue North. The substation receives four 115 kilovolt (kV) transmission lines, entering the substation on overhead and underground lines along Taylor Avenue and underground lines along Broad Street and Thomas Avenue. Denny Way is the location of an underground transmission arterial, as is Alaskan Way. The waterfront area between Massachusetts Street and Denny Way is served by an underground distribution network (Seattle City Light 1990). Figure 4-14 illustrates the major electrical facilities in the study area.

4.13.2 Water

The Seattle Public Utilities serves retail customers of Seattle and portions of King County. Water distribution lines are located under most streets in the South Lake Union and Elliott Bay Subbasins (Seattle Water Department 1994).

Figure 4-14

4.13.3 Solid Waste

Seattle Public Utilities contracts with private firms for the collection of residential and commercial garbage, recyclables, and yard waste within Seattle. SWU provides for disposal of all garbage generated within Seattle. Seattle operates two transfer stations and uses two privately-owned transfer stations. Solid waste collected at the transfer stations is transported by rail to an Oregon landfill (Seattle 1994c).

4.13.4 Natural Gas

Puget Sound Energy (formerly Washington Natural Gas Company) provides natural gas service to Seattle and the subbasins. High pressure gas mains are located along Westlake Avenue, Battery Street, and Elliott Avenue West. Local distribution mains are located in most major streets in both subbasins.

4.13.5 Wastewater

Seattle Public Utilities is responsible for the collection of wastewater within Seattle. The City system collects residential, commercial, and industrial wastewater and delivers it to interceptor lines operated by King County. The wastewater collected from the study area is treated at the West Point Treatment Plant. Collector sewer lines ranging from four to twelve inches in diameter are located under most major streets in both subbasins. In the study area, wastewater facilities operated by King County include the Denny Local Trunk, serving the area north of Denny Way and east of Elliott Avenue to Queen Anne Avenue; the existing Lake Union Tunnel, a 100-year old, 72-inch brick pipeline under the Seattle Center; and the Denny Regulator, located in Myrtle Edwards Park along the Elliott Bay waterfront. Figure 4-15 illustrates these County facilities. Because much of the Seattle's wastewater collection system was constructed near the turn of the century, many combined sewer/stormwater systems exist, particularly in the oldest sections of Seattle. Combined sewer/stormwater pipes exist in both the Lake Union and Elliott Bay subbasins. Within the South Lake Union and Elliott Bay subbasins, there are currently seven active CSO outfalls into the south southeast and west sides of Lake Union and four CSO outfalls into Elliott Bay along the waterfront, including the Denny Regulator. Figure 4-15 shows King County wastewater facilities and outfalls in the area.

4.13.6 Stormwater

Seattle Public Utilities maintains the stormwater collection and disposal system within Seattle. As previously described, much of the stormwater generated within the older portions of Seattle, including the Lake Union and Elliott Bay Subbasins, is directed to a combined sewage/stormwater system. There is also an extensive network of storm drain pipes conveying stormwater to both Lake Union and Elliott Bay. Stormwater discharges are regulated under the NPDES municipal stormwater permits, promulgated by the EPA, and administered by Ecology. Seattle completed initial permitting requirements in November 1992, including inventory monitoring. Ecology issued a general watershed-based permit in July 1995.

Figure 4-15

South Lake Union Subbasin. Eight National Pollutant Discharge Elimination System (NPDES) permitted CSO outfalls drain six basins and discharge into Lake Union. Most of the discharges are directed to the southern portion of the lake.

Elliott Bay Subbasin. Because this basin is largely combined, there are no dedicated city-maintained stormwater pipelines or outfalls into Elliott Bay within the project area. Stormwater, along with sanitary sewage, is directed into Elliott Bay through CSO outfalls. Stormwater from the harbor side of Alaskan Way is not collected in the combined sewer system. Individual property owners along the waterfront are responsible for surface water drainage, which is directed into Elliott Bay through numerous small outfalls (Port of Seattle 1989).

4.13.7 Gasoline

Various gasoline stations are located throughout the project area. Electricity and natural gas could be provided to facilities within the subbasins. The existing gasoline stations could provide fossil fuels for construction, maintenance, and worker vehicles.

4.13.8 Emergency Services

Fire Protection. Three fire stations provide fire protection service to the project area (Henifin 1994):

Fire Station # 8, located at 110 Lee Street (Queen Anne Hill)
Fire Station # 2, located at 2334 Fourth Avenue
Fire Station #22, located at 901 E. Roanoke Street (South Lake Union)

Police Protection. Police protection is provided for the entire study area from Seattle's West Precinct Station located at 610 Third Avenue.

4.14 SOCIOECONOMICS

This section provides a summary of population, housing, and economic conditions in the South Lake Union and Elliott Bay Subbasins. Refer to Appendix R for a more detailed report including tables on socioeconomic conditions in the project area and in the City of Seattle as a whole.

4.14.1 Population

Population density is high across most of the project area, with the exception of south Lake Union, where commercial land uses predominate. Density is particularly high on the south slopes of Queen Anne Hill, which is dominated by large multi-family units. According to 1990 U.S. Census data, project area population totaled approximately 20,700, an increase of 1,800 over 1980 population. The Puget Sound Regional Council projects continued population growth, averaging 2.3 percent annually, from 1990 to 2010 for the forecast analysis zone that includes the project area. Like the City of Seattle as a whole, the majority of project area population is white. In 1990 Seattle's population was approximately 75 percent white, while the project area average was approximately 89 percent. African American and

Pacific Islander populations comprised approximately 4 percent of the project area each, with Hispanic and Native American, Eskimo, and Aleut comprising the remaining 4.4 percent.

4.14.2 Housing

Both Seattle as a whole and the project area contain a mix of single-family housing and high-density, multi-family residential development. In 1990 there were approximately 15,200 housing units in the project area. Much this housing was found in multi-family units. The number of persons per dwelling unit was well below two throughout the project area, indicating that many people were living alone. Approximately 15 percent of project area residents owned their homes, well below the citywide average of 49 percent. The median home value in the project area in 1990 was approximately $216,500, well above the citywide average of $138,000. The ratio of assisted housing units to total units is high south of Lake Union and near Elliott Bay south of Mercer Street. Approximately 1,300 of the dwelling units in the south Lake Union area in 1994 were assisted units, and almost all of these were rentals. About 75 percent of these assisted units were studio apartments managed by non-profit organizations.

4.14.3 Commercial and Industrial Activity

Commercial and/or industrial activity in Seattle is concentrated throughout the downtown core, major industrial areas, commercial hubs, and smaller neighborhood centers. Specific information on the type, extent, and location of commercial and industrial activity in the project area is limited. Existing information shows that industrial land prices in South Lake Union were among the highest in the Seattle metropolitan area, averaging $25 to $40 per square foot. As a result, many of the traditionally land-intensive manufacturing and industrial activities have been replaced by increasing finance, service, real estate, medical research, and related establishments. This trend is expected to continue.

4.14.4 Employment

Between 1980 and 1990 the total number of jobs in Seattle increased by 21 percent with the service sector reporting the largest job increases. Reflecting this strong job growth, the 1990 citywide unemployment rate was approximately 4.9 percent. By 1994, total employment by project area businesses was approximately 73,000. Similar to citywide conditions, approximately 38 percent of this employment was in the services sector. The greatest job growth in the project area is expected to be in service, finance, real estate, and insurance. Declines in manufacturing employment are expected to continue. South Lake Union and the area along Elliott Bay, south of Mercer Street, will continue to be the major job centers in the project area.